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Appendix D
Site Investigation Methods

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SITE INVESTIGATION METHODS

The Supplemental Studies Investigation (SSI) included completion of investigative tasks in the following areas of the Site:

- Industrial Area - Building 142 and Building 267 Pipelines,
- Industrial Area - Main Buildings Area,
- Main Airport/Industrial Area Storm Sewers,
- Runway Area,
- North Base Landfill,
- Meade Heights,
- Susquehanna River, and
- the HIA Production Well Field within the Industrial Area.

Figure D-1 shows the general locations of these areas at the Site. The proposed investigative tasks and those completed are summarized in Table D-1. Modifications to the Work Plan and reasons for these modifications are also provided. The following sections discuss specific field investigation methods, numbers of samples, and sample locations.

Investigation activities were conducted in accordance with the Final SSI Work Plan and Quality Assurance Project Plan (QAPP) prepared by ERM in July 1994. The activities included:

- Building 142 pipeline integrity survey;
- GPR surveying and line locating;
- direct push soil gas, soil, and ground water sampling;
- storm sewer sediment sampling;
- radiological survey of former Radium Dial Paint Shop;
- soil boring and sampling;
- surface water, sediment, and biological stream sampling;
- analytical field screening and laboratory analysis;
- well installation and ground water sampling;
- well borehole geophysical and television logging;

Figure D-1
Generalized Base Map
Middletown Airfield NPL Site
Middletown, Pennsylvania

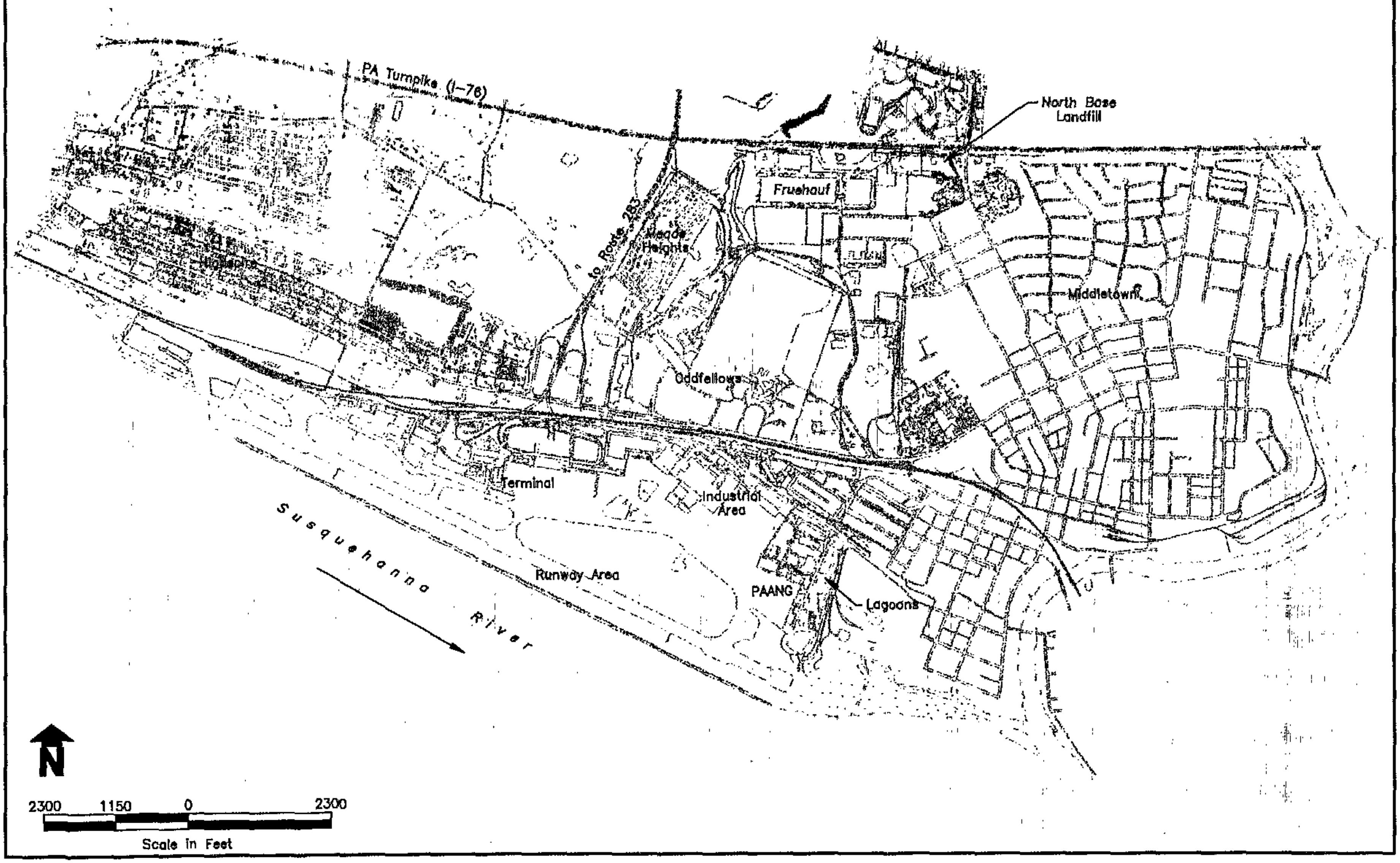

Table D-1
Summary of Proposed and Implemented Monitoring Programs
Middletown Airfield NPL Site

Area of Concern	Statement of Work	Implemented Program	Reason for Modification
Industrial Area - Building 142/267 Pipeline/Lagoons	• Camera survey to determine integrity of pipeline from Building 142 to Lagoons.	• Dye study performed on the pipeline.	• Camera survey impractical due to absence of manholes and presence of right angle turns and vertical drops in the pipeline.
	• Conduct direct push soil vapor sampling at 60 locations along Bldg. 142 pipeline and 40 locations around Waste Sump House (Bldg. 267) and pipelines.	• Conducted direct push sampling at 84 locations: IAP-SV1 through -SV5, -SV8 through -SV20, -SV22 through -SV31, and -SV65 through -SV76 around the Waste Sump House and pipelines; and -SV32 through -SV64, and -SV77 through -SV84 along the Building 142 pipeline.	• Spacing of the sample location per the work plan resulted in use of less sample points. Relatively few detects measured.
	• Collect direct push soil samples from 20 locations along Bldg. 142 pipeline and Waste Sump House, and 5 locations around Lagoons.	• Implemented as planned, IAP-GSI through IAP-GS20 along Bldg. 142 pipeline and Waste Sump House, and IAL-GS21 through IAL-GS25 around lagoons	• NA
		• Collected 8 direct push ground water samples along the Building 142 pipeline.	• Ground water samples were collected to characterize a stretch of the 142 pipeline that could not be tested during the dye study.
	• Collect samples from 12 HSA borings: 10 borings along pipeline routes and 2 borings at Lagoons.	• Implemented as planned, borings IAP-SB1 through IAP-SB10 along the pipeline and borings IAL-SB11 and IAL-SB12 at the lagoons.	• NA
Industrial Area - Buildings 142/267 Pipeline/Lagoons	• Install and sample 2 shallow and 2 intermediate depth monitoring wells along Bldg. 142 pipeline; sample shallow wells for VOCs with 14 day turnaround to locate intermediate wells.	• Four shallow wells installed, ERM-2S, -3S, -6S, and -28S.	• Based on direct push sampling data, two additional shallow well locations selected.

Table D-1
Summary of Proposed and Implemented Monitoring Programs
Middletown Airfield NPL Site

Area of Concern	Statement of Work	Implemented Program	Reason for Modification
		• No intermediate wells installed along pipeline, wells used in Main Building Area.	• Ground water results from shallow wells did not warrant installation of intermediate wells.
	• Install and sample 1 shallow and 1 intermediate depth monitoring well at Lagoons.	• Implemented as planned, wells ERM-1S and ERM-1I.	• NA
	• Collect soil samples from 3 shallow well borings.	• Soil samples were collected from boring for wells ERM-1S, -2S, -3S, -6S, and -28S.	• Two additional wells were installed; therefore, samples from these borings were also collected.
Industrial Area - Main Buildings Area	• Collect samples from each of 30 HSA borings.	• Soil samples were collected from 30 HSA borings, IAB-SB13 through IAB-SB42.	• NA
	• Install and sample 3 shallow, 3 intermediate depth, and 1 deep monitoring well; sample shallow wells for VOCs with 14 day turnaround to locate intermediate and deep wells.	• Five shallow wells installed, ERM-4S, -5S, -27S , -34S, and -35S.	• Additional shallow wells installed to define contaminants in the area peripheral to the lagoons.
		• Installed five intermediate and one deep well: ERM-10I, ERM-32I through -35I, and -32D.	• Additional intermediate wells installed to investigate contaminants detected in shallow well locations.
	• Collect soil samples from 3 shallow well borings.	• Soil samples were collected from boring for wells ERM-4S, -5S, -27S, -34S, and -35S.	• Two additional wells were installed; therefore, samples from these borings were also collected.

Table D-1
Summary of Proposed and Implemented Monitoring Programs
Middletown Airfield NPL Site

Area of Concern	Statement of Work	Implemented Program	Reason for Modification
		• Performrd radiological survey of Builidng 135, identified as a former Radium Dial Paint Shop.	• Historical documentation indicated clean-up of a spill at this paint shop.
Main Airport/Industrial Area Storm Sewers	• Collect 30 sediment samples from storm drains.	• Collected 28 sediment samples, samples STSD-1 through STSD-28.	• Collection of samples at additional locations was attempted but no sediment was present.
		• Provided support for USEPA in collecting sediment samples from vaults J-5, J-6, J-7, J-8, and J-12.	• To further examine potential source areas near vault J-5.
		• Performed radiological survey of 3 storm sewer vaults near Building 135. Collected 6 wipe samples from 3 vaults: samples STSD-RAD1 through -RAD6.	• To assess potential presence of residual radiological contaminants in storm sewers.
Background Soils	• Collect surface samples (0-2") and 3 subsurface samples from each of 5 borings in background locations (discrete samples for VOCs analysis and composite samples for other parameters).	• Implemeted as planned. Borings BK-SB43, -SB45, -SB47, -SB49, and -SB51.	• NA
Background Soils (cont.)		• Also collected two additional surface samples at each background sampling location. Surface soil locations BK-SB44, -SB46, -SB48, -SB50, and -SB52.	• Additional surface samples collected to support statistical analyses during the risk assessment.

Table D-1
Summary of Proposed and Implemented Monitoring Programs
Middletown Airfield NPL Site

Area of Concern	Statement of Work	Implemented Program	Reason for Modification
North Base Landfill	• Collect up to 75 direct push ground water samples at an average depth of 20 feet.	• Collected 2 direct push ground water samples in the North Base Landfill area.	• Ground water samples could not be *successfully collected using direct* push methodology because the water table was below 20 feet or bedrock was very shallow.
	• Install and sample 3 shallow and 3 intermediate Sentinel wells.	• Installed and sampled 3 shallow, 3 intermediate and 3 deep Sentinel wells: wells ERM-7S, I, D (SENT), ERM-8S, I, D (SENT) and ERM-9S, I, D (SENT).	• The deep bedrock wells in the sentinel well clusters were added to monitor zones originally intended for the piezometers deleted from the program.
	• Install 2 shallow, 2 intermediate, and 2 deep piezometers.	• Piezometers were not installed.	• The short distance between the landfill and MID-04 as well as limited locations for well installation resulted in these wells not being installed.
	• Install and sample 2 shallow and 7 intermediate monitoring wells.	• Installed 8 shallow wells: ERM-11S through -14S, -16S, -17S, -29S, and -30S. Installed 10 intermediate depth wells: ERM-11I through -17I, -29I, -30I, and -31I.	• Additional shallow and intermediate wells were located to better define extent of contamination downgradient from the Fruehauf facility and the NBL.
		• Added radium^{226} parameter to ground water samples from wells ERM-12S, -12I, -31I, and RFW-01.	• To check if radium dials had been disposed of at the NBL.
Meade Heights	• Collect surface water and sediment samples from 4 locations in stream.	• Implemented as planned, samples MH-SED/SW 1 through 4.	• NA

Table D-1
Summary of Proposed and Implemented Monitoring Programs
Middletown Airfield NPL Site

Area of Concern	Statement of Work	Implemented Program	Reason for Modification
Meade Heights (cont.)	• Perform aquatic survey of macroinvertebrates, aquatic insects, and fish at 4 locations.	• Implemented as planned.	• NA
		• Performed Geoprobe soil sampling at 15 locations MH-GPS1 through MH-GPS15. Collected 2 samples per each location.	• Locations were sampled to characterize the potential for contamination in fill materials west of the Fruehauf facility.
Susquehanna River	• Collect surface water and sediment samples from 4 locations in River.	• Implemented as planned, samples SR-SED/SW 5 through 8.	• NA
Industrial Area Capture Zone Tests	• Install and sample 6 shallow, 6 intermediate depth, and 6 deep monitoring wells. Located 2 well nests at each of 3 HIA production wells.	• Implemented as planned, HIA- 2: ERM-25S, I, D and -26S, I, D. HIA-9: ERM-21S, I, D and -22S, I, D. HIA-13: ERM-23S, I, D and -24S, I, D.	• NA
HIA Production Wells	• Conduct borehole camera survey of 3 HIA wells.	• Implemented as planned.	• NA
	• Conduct borehole geophysical logging at each of 3 HIA wells under static conditions. Based on logs, collect depth-specific samples from 5 intervals in each well under flowing and static conditions.	• Implemented as planned. HIA-13 (97), (138), (345), (480), (725); HIA-2 (103), (175), (238), (310), (412); HIA-9 (102), (143), (201), (256), (420).	• NA
Runway Area	• Install and sample 3 shallow and 2 intermediate depth monitoring wells.	• Implemented as planned, wells ERM-18S, -19S, -20S and intermediate depth wells ERM-18I and -20I.	• NA

Table D-1
Summary of Proposed and Implemented Monitoring Programs
Middletown Airfield NPL Site

Area of Concern	Statement of Work	Implemented Program	Reason for Modification
Runway Area (cont.)		• Installed and sampled 5 HSA borings, borings RA-SB53 through -SB57.	• Additional data needed to supplement limited existing data in this area.
Deep Ground Water Flow Determination	• *Install and sample 3 deep (800')* monitoring wells.	• Not implemented.	• Based on geologic setting, little additional information to be gained.
Existing Monitoring Wells	• Sample 48 existing monitoring wells.	• Successfully sampled 45 of 50 exisiting monitoring wells (GF-, RFW-, and WRT Series).	• Well GF-203 had an obstruction, wells GF-211 and GF-225 were dry, and wells GF-225 and RFW-5 were paved oper.
Production Wells	• Sample MID-04 and 13 HIA production wells.	• Implemented as planned; sampled: HIA-1, -2, -3, -4, -5, -6, -9, -10, -11, -12, -13, -14, -17, -18, and MID-04.	• NA
Residential Wells	• Sample up to 8 residential wells, including Odd Fellows Home well.	• Sampled 8 wells but not the same wells sampled during the RI.	• Residential wells closer to potential source areas were selected for sampling.
Site-Wide Water Source	• Sample potable water source and water from drillers tank used for drilling and decontamination during field investigation.	• Implemented as planned,	• NA
SVE Pilot Testing	• Install 1 SVE 4" vacuum well and 3 SVE monitoring piezometers and perform OVA headspace screening on soil samples collected from ground surface to water table or bedrock.	• Not implemented.	• Analytical data does not support SVE pilot testing.

Table D-1
Summary of Proposed and Implemented Monitoring Programs
Middletown Airfield NPL Site

Area of Concern	Statement of Work	Implemented Program	Reason for Modification
SVE Pilot Testing (cont.)	• Based on OVA screening, select 3 samples from each boring for analysis.	• Not implemented.	• NA
	• Collect vapor samples on a regular basis during 3-4 day pilot test.	• Not implemented.	• NA
Quarterly Monitoring Program	• Quarterly sampling of the Sentinel wells at the North Base Landfill through the third calendar quarter of 1995.	• Two sampling events performed in August and November 1995.	• NA
	• Collect surface water and sediment samples from 4 locations on the Susquehanna River for 5 quarterly monitoring rounds subsequent to initial sampling.	• Five sampling events performed in August and November 1994 and March, June, and November 1995.	• NA

Notes

(1) HSA = hollow stem auger

SW = surface water sample
SD = sediment sample
NA = Not applicable

- slug tests and pumping tests; and
- IDW management.

ERM-FAST® provided on-site field screening (Level II, by Gas Chromatograph [GC]) of soil vapor, soil, and ground water and laboratory analyses (Level III, by Gas Chromatograph/Mass Spectrometer [GC/MS]) of soils during the field investigation. Unless otherwise indicated, samples submitted to ERM-FAST® for "field screening" were analyzed by GC for the following selected VOCs and SVOCs: tetrachloroethene (PCE), trichloroethene (TCE), 1,2-dichloroethene (1,2-DCE), 1,2-dichloroethane (1,2-DCA), carbon tetrachloride (CCl_4), vinyl chloride, benzene, toluene, ethylbenzene, xylene (BTEX), chlorobenzene, and 1,2-, 1,3-, and 1,4-dichlorobenzenes.

Select split spoon sediment samples from the Industrial Area soil borings and monitoring wells and from the soil samples from the background borings were submitted for field "laboratory analysis" and analyzed by GC/MS for the Target Compound List (TCL) VOCs plus up to ten Tentatively Identified Compounds (TICs). These samples were analyzed with a 48 hour turnaround time to provide data for subsequent decision making. Samples for other analytical parameters were submitted to the off-site laboratory for analysis.

D.1 DECONTAMINATION PROCEDURES

All non-disposable equipment used for the collection, preparation, preservation, and storage of environmental samples were decontaminated prior to use and after each subsequent use to prevent cross-contamination between sampling locations. Decontamination of equipment took place at the designated decontamination area located on the south side of the Maintenance Shop, Building 514 at HIA. Decontamination water was collected and handled according to procedures described in Section D.18.3.

A decontamination pad was constructed specifically for this project by the drilling subcontractor. The area excavated for the pad consisted of fill material. Construction of the pad consisted of the following layers: 1 to 2 feet of sand; plastic sheeting; about 1 foot of sand; and railroad ties with more sand added on top to make a level surface. The decon pad was removed at the completion of the field investigation program and the area leveled. Disposition of the decontamination pad is discussed in Section D.18.1.

D.1.1 *Drilling Equipment Decontamination*

Geoprobe and drilling equipment was decontaminated prior to initial use, between boring locations, and at the completion of drilling activities. Items which were decontaminated included all downhole equipment which contacted potentially contaminated material (probing tools, augers, air hammers, cables, and drilling rods) and the back of the vehicle/rig.

The equipment was decontaminated by manual scrubbing with non-phosphate soap and potable water, as necessary to remove foreign material, followed by thorough steam cleaning. The known water source was a hydrant located adjacent to the decontamination area and was sampled at the beginning of the field investigation. Water supply to the hydrant is from the HIA Water Department potable water distribution system.

D.1.2 *Sampling Equipment Decontamination*

All non-disposable sampling equipment (hand augers, split spoon samplers, stainless steel bowls, stainless steel spoons, hand augers, etc.) was decontaminated as follows:

- manual scrub with laboratory grade, non-phosphate soap and tap water from the established water source, using a brush if necessary to remove particulate matter and surface films;
- thorough rinse with approved potable water;
- rinse with 10% nitric acid (only for samples collected for metals analysis);
- tap water rinse;
- pesticide grade methanol rinse;
- triple rinse with distilled/deionized water;
- air dry.

At a minimum, wash water used to clean split spoon samplers was changed between each boring and more often as needed.

Sampling equipment which was stored for future use or was transported to a sampling location was wrapped completely with aluminum foil to prevent contamination.

The pumps used for developing and purging the wells were decontaminated between each use. Submersible pumps were placed in a container of clean tap water, and 4 to 5 gallons of water were run through the pump and discharge hoses. The clean water rinse was repeated using a second container filled with distilled water. Purge lines to or from pumps were used only once and discarded to eliminate potential cross-contamination.

Stainless steel or PVC bailers used for sampling and/or purging monitoring wells were dedicated to individual monitoring wells. After each use, the bailer was decontaminated as described above, placed in a plastic bag that was clearly labeled with the monitoring well number, and stored for future use in an appropriate location on the Site.

D.2 GROUND PENETRATING RADAR (GPR) SURVEY

GPR was used to identify and map the locations of the Building 142 pipeline and the Building 267 pipelines. Although accurate, HIA utility diagrams did not depict either the Building 142 or 267 pipelines, or any underground utilities installed subsequent to 1977. GPR data were collected from numerous short cross sectional runs across the Building 142 pipeline and the Building 267 pipelines to accurately locate the pipe. Long runs were made parallel to each of the known pipelines to identify all underground lines that entered or crossed the pipelines in question to allow maximum flexibility in selection of direct push sampling and drilling locations. GPR surveys were also conducted in the vicinity of Building 29, 133, and 142 to identify buried foundations and other underground lines in order to identify safe drilling locations.

D.2.1 Techniques

The GPR method uses focused high frequency electromagnetic waves to produce a continuous cross sectional picture of the subsurface. These pulses are transmitted into the subsurface from an antenna (transducer). When the impulse signal reaches a layer or object possessing contrasting electrical properties, part of the energy is reflected toward the surface where it is detected by a receiving transducer. The received signal is sent to a controlling unit where it is processed and transmitted to an electrostatic printer. A continuous cross-sectional image is generated as the receiving and transmitting transducers are pulled along the ground surface.

The GPR survey was performed using a SIR System-3 Subsurface Interface Radar System, manufactured by Geophysical Survey Systems, Inc. (GSSI) of Hudson, New Hampshire. A 300 megahertz (MHz) transducer was chosen to provide the needed resolution for the required depth of penetration. ERM's subcontractor for the GPR survey work was Quantum Geophysics, Inc. of Paoli, PA.

D.3 BUILDING 142 PIPELINE INTEGRITY SURVEY

The purpose of the survey was to locate potential leak sites along the entire length of the pipeline extending from Building 142 to lagoons which are located on the east side of the PAANG. At the time of the survey, Building 142 was occupied by Chloe Eichelberger, a textile dying company which discharges process water through the Building 142 pipeline to their lagoons. Figure D-2 shows the approximate location of the pipeline.

The Building 142 pipeline does not by design discharge into Post Run, but the steel pipeline travels inside the Post Run culvert between the point where Post Run enters HIA property and the point where the concrete culvert ends and Post Run travels in an open ditch on PAANG property. There is a short segment (≈ 30 feet) where the steel pipeline crosses above the now open channel of Post Run. The Building 142 pipeline is buried parallel to the open ditch of Post Run just upgradient from the lagoons into which the pipeline discharges.

A tractor-driven video camera was originally to be used to survey the inside of the Building 142 pipeline to locate potential leak sites. The camera survey was deleted from the program because of the large number of turns and vertical drops. Access to the pipeline is limited because the pipeline is buried and welded. A dye study was substituted for the video survey. The intent of the dye study was to help identify leaks only from that segment of the Building 142 pipeline where it traveled inside of the Post Run culvert. Direct push soil vapor and soil sampling was also completed along the entire length of the Building 142 pipeline to investigate whether contaminants may have leaked (see Section D.4 and D.5).

D.3.1 Techniques

Rhodamine WT dye solution was added directly to the wastewater sump within Building 142. The dye is purplish-red in color. The contents of the sump were pumped into the pipeline at an average flow rate of approximately 500 gallons per minute (gpm). Two 0.5 gallon slugs of dye solution were added to the sump which contained approximately 1,400 gallons. The slugs of dye were added about 3.5 hours apart. The concentration of the Rhodamine WT within the sump was approximately 71 ppm of Rhodamine by volume. Water samples were collected from the culvert at 4 locations between where the pipeline enters the Post Run

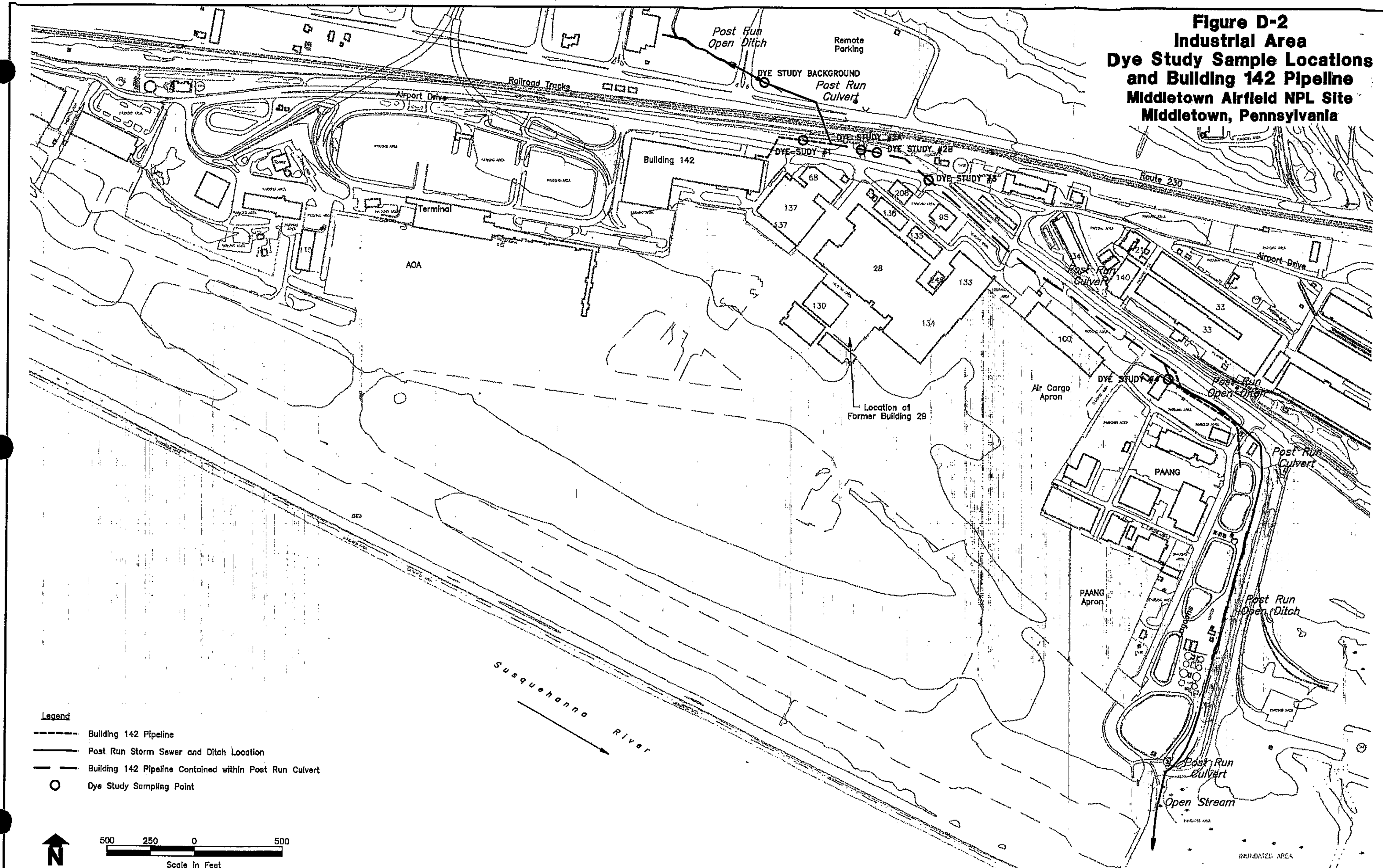

Figure D-2
Industrial Area
Dye Study Sample Locations
and Building 142 Pipeline
Middletown Airfield NPL Site
Middletown, Pennsylvania

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culvert and Post Run exits the culvert at the PAANG. An additional location was sampled at an upgradient point along Post Run on the north side of Route 230. This upgradient sample was used as a reference or background sample which allowed comparison with the other 4 locations. The Building 142 Pipeline and these sample locations are plotted on Figure D-2. The samples were labeled as 1, 2A, 2B, 3, and 4 along the pipeline, with the upgradient sample designated as "Background".

Sampling began 30 minutes after the first dye slug was added to the sump and continued approximately every 30 minutes for 8 hours. Based on stream velocity estimates at each point, it was determined that a conservative estimate of the average velocity through the culvert was 6 feet per minute (ft/min). A Post Run travel time of 5 hours from Point No. 3 to point No. 4 was assumed based on the scaled distance between the points (approximately 1,800 feet). Therefore, sampling continued for approximately 5 hours after addition of the second dye slug.

A sample container was dedicated for use at each monitoring point and was rinsed three times with distilled water between samples to prevent cross contamination. Equipment blanks (background water collected with each dedicated sampler) were collected, as was an additional equipment/trip blank (distilled water as used in the field for rinsing samplers). Samples were poured into identical clear glass 40 ml sample bottles, and labeled with location and time of sampling. Samples were stored overnight at ambient temperature in a box with a lid for analysis the following day. Preservation was not necessary, but the samples were protected from light to prevent photodegradation.

Samples were analyzed the following day using a Turner Designs Model 10-005 analog fluorometer. The fluorometer was calibrated and operated according to the manual supplied with the instrument. The fluorometer was calibrated to read between 0 and 5 parts per billion (ppb), with a linear range as low as 10 parts per trillion (ppt). No temperature correction was necessary since all samples, blanks, and standards were at the same temperature. Fluorometer analysis found no samples that were different than background. Therefore no areas along the Post Run culvert were specifically identified for focused direct-push sampling.

D.4 *DIRECT PUSH SOIL VAPOR SAMPLING*

A Geoprobe System® was used to collect soil vapor samples along the Building 142 and 267 pipelines and in the vicinity of Building 267 (Waste Sump House) to investigate whether volatile contaminants may have leaked from the pipelines and impacted soils. The Building 142 pipeline was used to transport contaminated ground water from well HIA-13 to Building 142 for process water and then to the lagoons located east of the PAANG compound. The Building 267 pipelines (currently unused process lines) carried industrial chemicals from current and former buildings to the waste sump.

The soil vapor sampling was conducted along the Building 142 pipeline which extends approximately 4,200 feet from Building 142 eastward to the lagoons. Soil vapor sampling was also conducted along the Building 267 pipelines between Building 142 and Building 267, and between Building 133 and Building 267. Figures D-3A and D-3B show the approximate sample locations along the Building 142 and 267 pipelines plotted based on field measurements from nearby site features. Of the 81 soil vapor samples, 40 samples were collected along the Building 142 pipeline and 41 samples were collected along the Building 267 pipelines and in the area of Building 267. At a minimum, samples were located at intervals of 100 feet along the pipelines. The final sampling locations were determined based on site conditions and consultation with the USACE.

The approximate pipeline locations were determined from the GPR survey and field observations. To avoid hitting the pipeline with the Geoprobe equipment, all soil vapor sampling locations were placed a minimum of 5 feet from the approximate center line of the pipeline. Entire stretches of the pipelines were cleared to allow flexibility in sample locations. All drilling locations were examined and approved by HIA maintenance personnel to help insure that underground utilities or the pipelines were not struck.

D.4.1 *Techniques*

ERM's subcontractor for all direct push soil vapor sampling was NCP Analytical Instruments, Inc. currently named Vironex of Newark, DE. The Geoprobe System® uses a hydraulic powered drive head to push small diameter probing tools into the subsurface with static force (the weight of the vehicle) and percussion (hydraulic hammer). Sample points designed for collection of soil vapor, soil, or ground water samples were attached to the end of 1-inch outside diameter probe rods and pushed to the desired sample depth. Samples were then collected directly through the sample probe rods.

Expendable steel sample points were attached to the end of the Geoprobe rods and advanced to the desired sample depth at each location. The depth of the pipeline invert was estimated between 4 and 8 feet below the ground surface. Soil vapor probes were installed to a depth of approximately 6 to 8 feet below the ground surface. When the sample depth was reached, the rods were retracted to disengage the expendable point and leave an open cavity for soil gas sampling. Dedicated tubing was inserted down the inside of the probe rods to the expendable point holder attached to the bottom of the rods, resulting in a continuous run of tubing from the sample level to the surface.

The soil vapor sample was collected using a pump attached to sample tubing to draw soil vapors to the surface. The pump was attached to a 1 liter Tedlar bag with a Teflon-lined septum. When the sample bag had been filled for an appropriate interval, it was delivered to ERM-FAST® for field screening. After the sample had been collected, the probe rods were removed from the hole and decontaminated. Lithologic logs for all direct push soil, soil vapor and ground water sampling locations are provided in Appendix A.

D.4.2 Sample Designations and Analyses

The 81 Geoprobe soil vapor sample locations were labeled with the prefix "IAP-SV" to designate "Industrial Area Pipeline-Soil Vapor", followed by the location number (1 through 84) and the sample depth. For example, a soil vapor sample collected from location number 20 at a depth of 6 feet below grade was designated IAP-SV20(6). The locations around Building 267 and its associated lines were IAP-SV1 through -SV5, IAP-SV8 through -SV20, IAP-SV22 through -SV31, and IAP-SV65 through -SV76. The locations along the Building 142 pipeline are IAP-SV-32 through -SV64, and IAP-SV77 through -SV84.

All soil vapor samples were screened for the following select VOCs and SVOCs: PCE; TCE; 1,2-DCE; vinyl chloride; BTEX; 1,2-DCA; CCl_4; chlorobenzene; and 1,2-, 1,3-, and 1,4-dichlorobenzene. The samples were analyzed within 24 hours to permit timely selection of either additional soil vapor points or locations to collect direct push soil samples.

D.5 DIRECT PUSH SOIL SAMPLING

A Geoprobe System® was used to collect soil samples to provide screening level confirmation of the soil vapor sampling results along the Industrial Area pipelines. The data was used to verify soil vapor sampling data and focus the selection of soil boring and monitoring well locations in later tasks.

Upon completion of the soil vapor sampling along the Industrial Area pipelines, 20 locations were sampled by direct push soil sampling methods (see Figures D-3A and D-3B). Two samples were collected per location, for a total of 40 soil samples. All samples were analyzed by ERM-FAST® to provide screening level data. Five locations, for a total of 10 soil samples, were sampled around the first, second, third, and fourth wastewater lagoons east of the PAANG compound (see Figure D-3C). An attempt was made to place a majority of the sample locations in areas where positive soil vapor results were recorded, and a smaller subset of the sample locations were to be in areas where negative soil vapor results were recorded to verify the field screening results. This was difficult to achieve because less contamination was encountered in the soils along the Building 142 and 267 pipelines than had been expected. Table D-2 provides a correlation between direct push soil vapor sampling locations and direct push soil sampling locations.

As a separate investigation, two samples were collected from 15 direct push soil sampling locations in fill materials distributed around the Meade Heights perennial stream (Figure D-4). Three of the 15 locations were in the fill materials near the residential area, with the remaining 12 locations in fill deposits situated on either side of the stream just west of the Fruehauf Corporation buildings. All sample locations were plotted on the base map using measured distances from nearby site features.

D.5.1 *Techniques*

The direct push soil samples were collected using the Geoprobe System®. A 1-inch O.D., 48 inch long, stainless steel sample tube was attached to the end of the probe rods and pushed or driven to the desired sample depth. Unlike split spoon samplers, the Geoprobe soil sample tube remains sealed by a piston tip while being advanced to the top of the sample interval. Extension rods were inserted down inside the probe rods after the top of the sample interval was reached, and a piston stop-pin at the

Figure D-3A
Industrial Area
Direct Push Screening Sampling
Buildings 267/142 Pipelines,
Western Area
Middletown Airfield NPL Site
Middletown, Pennsylvania

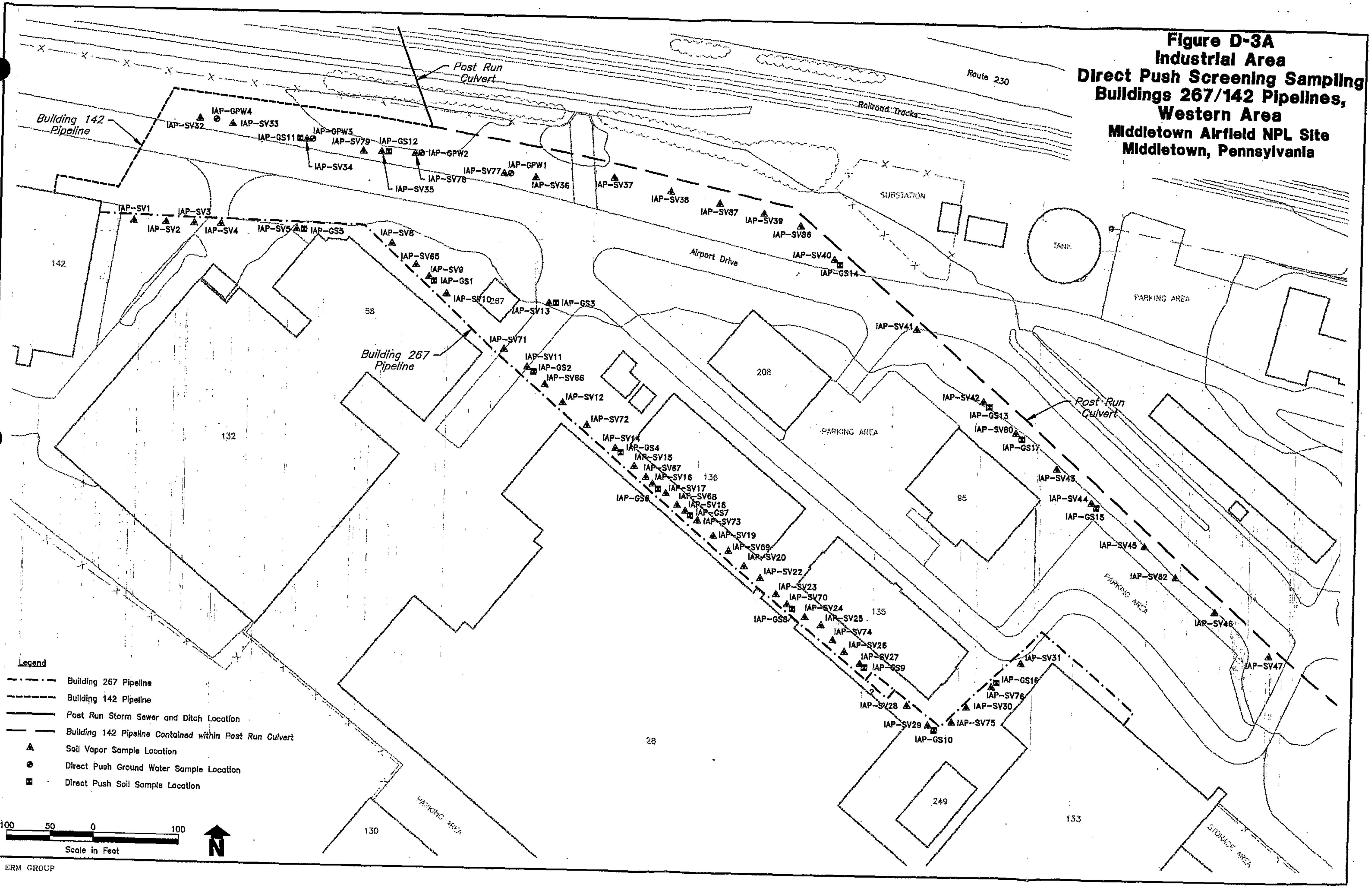

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Figure D-3B
Industrial Area
Direct Push Screening Sampling Locations, Building 142 Pipeline
Eastern Area
Middletown Airfield NPL Site
Supplemental Studies Investigation
Middletown, Pennsylvania

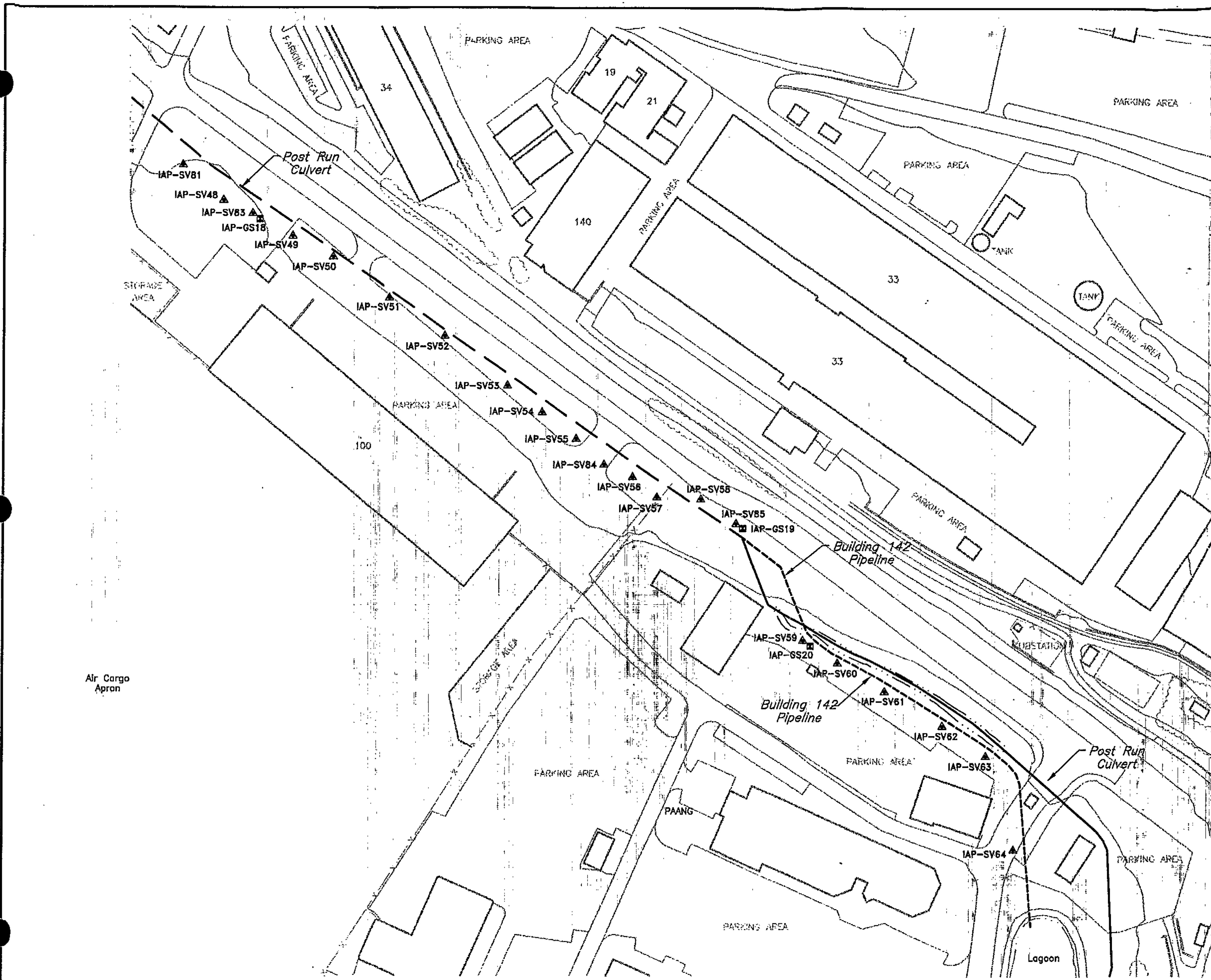

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Figure D-3C
Industrial Area
Direct Push Soil Sampling Locations Near Lagoons
Middletown Airfield NPL Site
Middletown, Pennsylvania

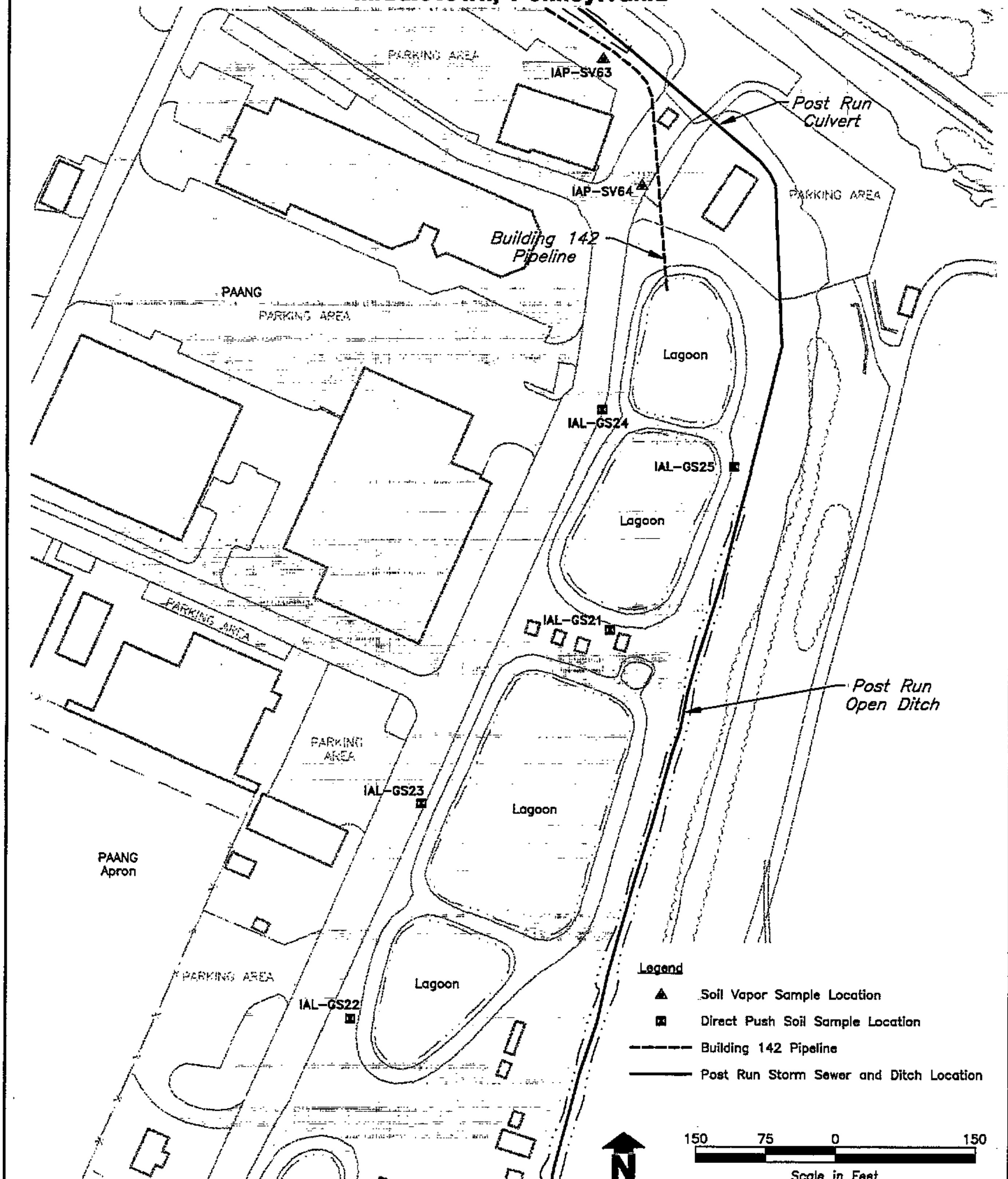

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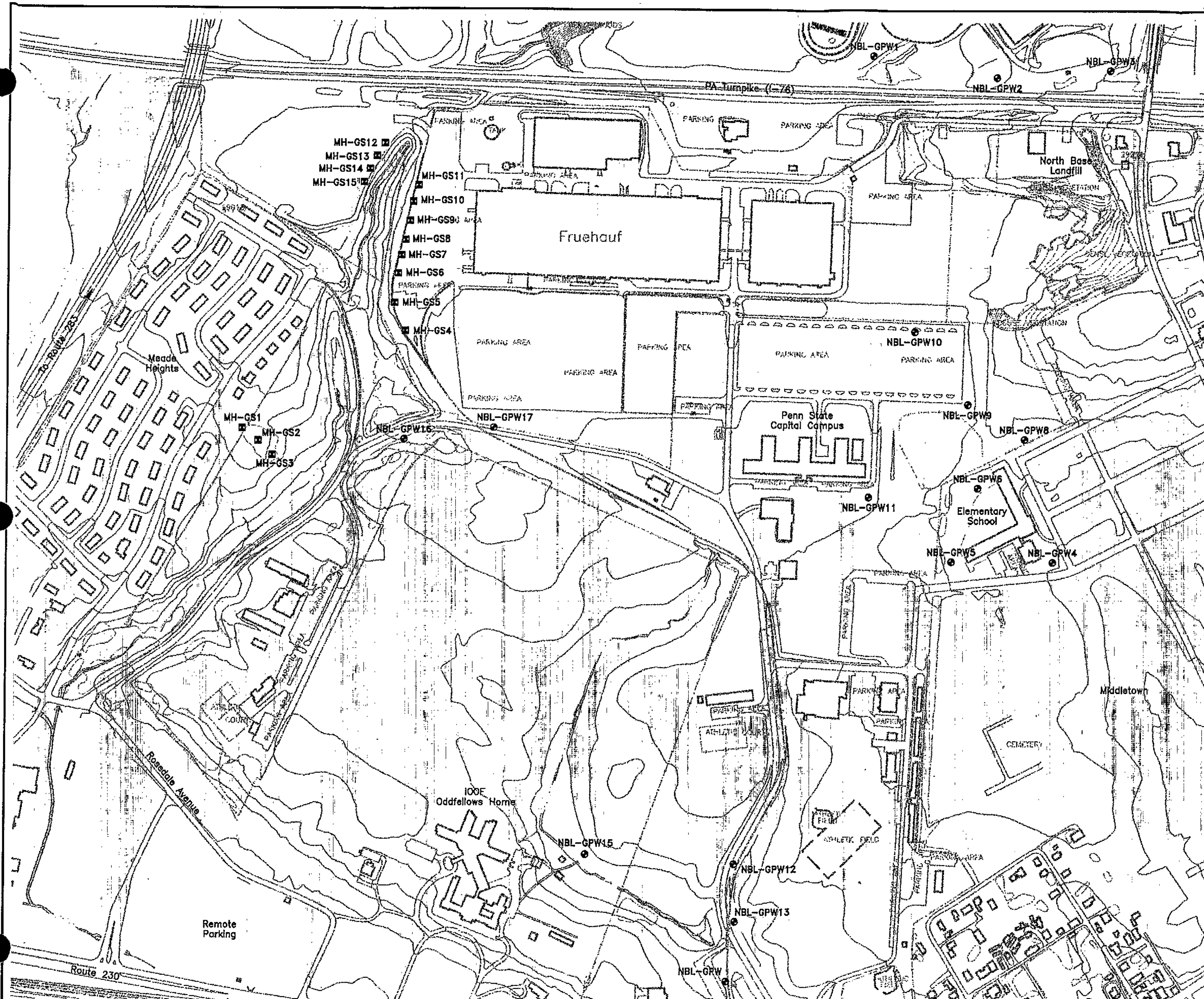
Table D-2
Correlation Table of Screening Sample Locations
with Soil Borings and Monitoring Wells
Middletown Airfield NPL Site

Soil Vapor Locations	Direct Push Soil Locations	Direct Push Ground Water Locations	Soil Borings/ Wells
IAP-SV8			IAP-SB2
IAP-SV9	IAP-GS1		
IAP-SV11	IAP-GS2		IAP-SB3
IAP-SV13	IAP-GS3		
IAP-SV14	IAP-GS4		
IAP-SV5	IAP-GS5		IAP-SB1
IAP-SV16	IAP-GS6		
IAP-SV18	IAP-GS7		
IAP-SV70	IAP-GS8		IAP-SB6
IAP-SV27	IAP-GS9		
IAP-SV29	IAP-GS10		
IAP-SV35	IAP-GS11		
IAP-SV77		IAP-GPW1	
IAP-SV78		IAP-GPW2	
IAP-SV34	IAP-GS12	IAP-GPW3	
IAP-SV32/33		IAP-GPW4	
IAP-SV42	IAP-GS13		IAP-SB10
IAP-SV40	IAP-GS14		
IAP-SV44	IAP-GS15		
IAP-SV76	IAP-GS16		
IAP-SV80	IAP-GS17		
IAP-SV83	IAP-GS18		ERM-28S
IAP-SV85	IAP-GS19		
IAP-SV59	IAP-GS20		
	IAL-GS24		IAL-SB12
	IAL-GS25		IAL-SB11

IAP = Industrial Area Pipeline
IAL = Industrial Area Lagoon

Note: Direct Push Soil Vapor and Direct Push Soil sampling locations are plotted on Figures D-3A, D-3B, D-3C and Soil Boring locations are plotted on Figure D-5.

Figure D-4
Meade Heights and North Base Landfill Area Direct Push Soil and Ground Water Sampling Locations
Middletown Airfield NPL Site
Middletown, Pennsylvania



trailing end of the sampler was removed. The probe rods and sampler was then driven the appropriate distance (up to 48 inches) for the desired sample interval. The piston was displaced upward into the sample tube as the soil sample was collected. The probe rods were then retracted from the borehole and the soil sample recovered.

The first pipeline area sample was collected at a depth approximately equal to the pipe invert depth, and the second sample was collected from just above the water table. The water table was usually encountered within 10 to 15 feet bgs (below ground surface). In the Meade Heights area, the first sample was collected from the 0 to 2 feet interval with the second sample from the 8 to 10 foot interval bgs.

If refusal was encountered before the desired sample depths were reached, the location was abandoned, and a second location was attempted adjacent to the first location. If refusal was encountered a second time at one location, an alternate sample location was selected based on the soil vapor results or other relevant field observations.

D.5.2 *Sample Designations and Analyses*

The 20 Geoprobe soil sample locations along the pipelines were labeled IAP-GS 1 through IAP-GS20 to designate "Industrial Area Pipeline - Geoprobe Soil", and the 5 Geoprobe soil sample locations around the wastewater lagoons were labeled IAL-GS 1 through IAL-GS25 to designate "Industrial Area Lagoons - Geoprobe Soil". The 15 Geoprobe soil sample locations around the Meade Heights drainage were labeled MH-GS 1 through MH-GS15 to designate "Meade Heights - Geoprobe Soil". There were samples collected from two different depths at each location. For example, the soil samples collected from location number 5 along the pipeline, from depths of 4 to 6 feet below grade, and from 13 to 15 feet below grade were designated IAP-GS5(4-6) and IAP-GS5(13-15), respectively.

All soil samples collected along the pipelines and around the lagoons were screened on-site by ERM-FAST® for the following select VOCs and SVOCs: PCE; TCE; 1,2-DCE; vinyl chloride; BTEX; 1,2-DCA; CCl_4; chlorobenzene; and 1,2-, 1,3-, and 1,4-dichlorobenzene. The samples were analyzed within 24 hours to allow for selection of soil boring locations. The soil samples collected around the Meade Heights drainage were submitted to the off-site laboratory for analysis for TCL VOCs, SVOCs and

TICs. Samples from locations MH-GS1, MH-GS2, and MH-GS3, centrally located in the Meade Heights area, were also analyzed for TAL total metals.

D.6 DIRECT PUSH GROUND WATER SAMPLING

A Geoprobe System® was used to collect ground water samples near the Building 142 pipeline and in the North Base Landfill area in order to define the stratigraphy of the alluvium aquifer, estimate the horizontal extent of the VOCs in the shallow unconfined aquifer, and aid in the placement of monitoring wells.

Seventy-five direct push locations were originally planned in the North Base Landfill area. Of the 16 locations attempted in this area, ground water samples were only collected from 2 locations (see Figure D-4). No further sampling was attempted due to dry conditions and dense weathered bedrock at shallow depths in most areas. An additional 4 locations were placed along the Building 142 pipeline at the request of the USEPA. At these 4 locations ground water samples were collected at two different depths along the Building 142 pipeline to provide information on vertical distribution of contaminants. These sample locations were chosen to provide information the westernmost section of the Building 142 pipeline where direct push soil vapor or direct push soil samples could not be collected directly adjacent to the underground pipeline (see Figures D-3A and D-4). The direct push ground water sampling locations are approximate based on field measurements to the nearest landmarks.

D.6.1 Techniques

Ground water sampling with the Geoprobe System® was accomplished by attaching a slotted steel well point to the end of the probe rods. The well point consists of a solid drive point which was threaded to a 3-foot long section of 0.02-inch slotted screen. The sampler was driven to the desired depth in the same manner as the soil vapor and soil sampling points. The water table was encountered between 10 and 20 feet below grade, with an average depth of 15 feet. The sampler was advanced to a depth of approximately 2 feet below the water table, and was then retracted approximately 2 feet. The expendable drive point was thereby disengaged, creating an open borehole. The inner core of the sampler, consisting of a stainless steel screen inside a perforated stainless steel sleeve, was then pushed into the borehole, and the ground water was allowed to enter the sampler. Ground water samples were collected using a peristaltic pump or manual displacement pump to lift water through a tubing system to the surface. The tubing was replaced between sample collection.

D.6.2 *Sample Designations and Analyses*

The Geoprobe ground water sampling locations were labeled with the prefix NBL to indicate their locations in or near the North Base Landfill area. The two locations where ground water samples could be collected were NBL-GPW10 and NBL-GPW14. The prefix, IAP, was used to indicate locations along the Building 142 pipeline. Ground water samples were collected from two different depths from locations IAP-GPW1 through -GPW4 along the pipeline. Each location number was followed by the interval from which the sample was collected.

All ground water samples were screened on-site by ERM-FAST® for the following select VOCs and SVOCs: PCE; TCE; 1,2-DCE; vinyl chloride; BTEX; 1,2-DCA; CCl_4; chlorobenzene; and 1,2-, 1,3-, and 1,4-dichlorobenzene. The samples were analyzed within 24 hours to allow for selection of soil boring and monitoring well locations. In addition, the sample from NBL-GW14 was also submitted to the off-site laboratory for TCL VOCs plus TICs.

D.7 SOIL BORINGS AND SAMPLING

This task was designed to collect additional soil samples to further define the occurrence of contaminant source areas and to delineate the extent of contamination identified along the pipelines, around the lagoons, in the industrial areas, along the runway, or in background locations. The locations were based upon results from the direct push soil vapor and soil sampling tasks on historic areas of known or potential contamination. In addition, background borings were drilled and samples collected and analyzed following the same protocols.

Soil borings were advanced in the following areas, and samples were collected from the unconsolidated material for both on-site field screening analyses and off-site laboratory analyses:

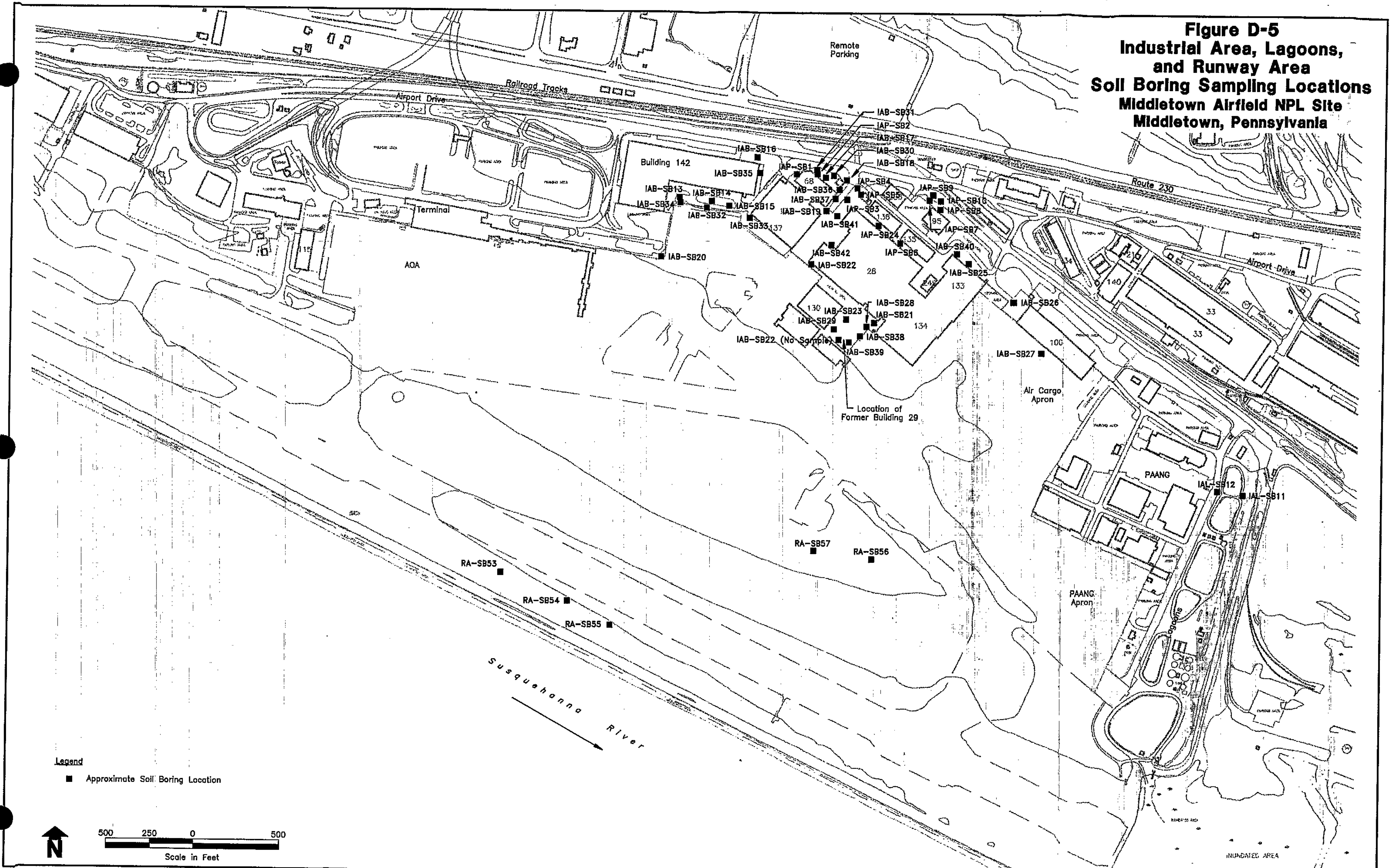
- 12 borings along the Industrial Area pipelines, including 10 borings along the pipelines and two borings in the wastewater lagoon area;
- 29 borings around the Industrial Area buildings, including 15 initial borings around the buildings plus 14 additional borings in locations determined based on the field screening results from the initial borings;
- 5 borings and 5 additional surface scrapes in areas determined to be indicative of background conditions. These locations were approved by the USEPA and USACE prior to drilling; and
- 5 borings in the Runway Area on either side of the runway itself.

Table D-2 lists co-located sampling points along the Building 142 and Building 267 pipelines. Locations for these borings are posted on Figure D-5. Soil boring and sampling locations were measured to the nearest permanent landmark and were plotted onto the base map. Lithologic logs are found in Appendix A.

D.7.1 Technique

Borings were advanced using hollow stem auger drilling methods, and subsurface samples were collected using split spoon samplers. ERM's subcontractor for the drilling and sampling of the borings was Aquifer Drilling and Testing - Mid Atlantic (ADT-MA) of Trenton, NJ. The split spoon sampling was accomplished using a 140-pound hammer to advance a 2-foot long stainless steel split spoon through the hollow stem augers

Figure D-5
Industrial Area, Lagoons, and Runway Area
Soil Boring Sampling Locations
Middletown Airfield NPL Site
Middletown, Pennsylvania



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(ASTM Method D1586-67). The number of hammer blows required to advance the sampler through each 6-inch interval over a distance of 2 feet were recorded. Auger flights were advanced only to the top of the interval to be sampled; the split spoons were then driven ahead of the augers. Individual, decontaminated split spoons were used to sample each interval.

Soil samples were visually described in the field by an ERM geologist. Descriptions included:

- USCS soil classification;
- consistency or density;
- moisture content;
- color (Munsell Soil Color Charts);
- bedding characteristics, fractures, or other descriptive features; and
- depositional type (alluvium, till, etc.).

D.7.1.1 *Industrial Area, Pipeline, and Runway Borings*

Formation samples were collected from the ground surface to the water table according to the following criteria:

- at 2.5 foot intervals from the ground surface to 10 feet below grade, and
- at 5 foot intervals from 10 feet below grade to the water table.

Boring depths varied between 5 and 20 feet below grade, with an average depth of 15 feet.

Surface scrape soil samples were collected at two boring locations along the pipelines, at the two locations in the Lagoon Area, and at 11 locations in the Main Building Area. Samples were collected from the top 2 inches of soil at each location by compositing soil using stainless steel spoons and bowls to achieve representative samples from each location. These samples were collected in locations where concrete/macadam was not present.

D.7.1.2 *Background Borings*

Formation samples were collected continuously from the ground surface to the water table or bedrock in each of the five background borings to characterize the soils (Figure D-6). Boring depths ranged from 8 to 14 feet, with an average depth of 11 feet below grade. Surface scrapes were collected at locations co-located with the background borings to provide additional shallow soils data which was used to establish background conditions. Lithologic logs for all soil boring locations are provided in Appendix A.

Formation samples for chemical analysis were collected from each of the following intervals: 0 to 2 inches (surface scrape samples), 2 to 6 inches, 2 to 5 feet, 5 feet to 10 feet, and from the bottom two split spoon samples above the water table. Samples from a second nearby location were taken from the 0 to 2 inch (surface scrape samples) and 2 to 6 inch intervals to provide additional background data for surface soils.

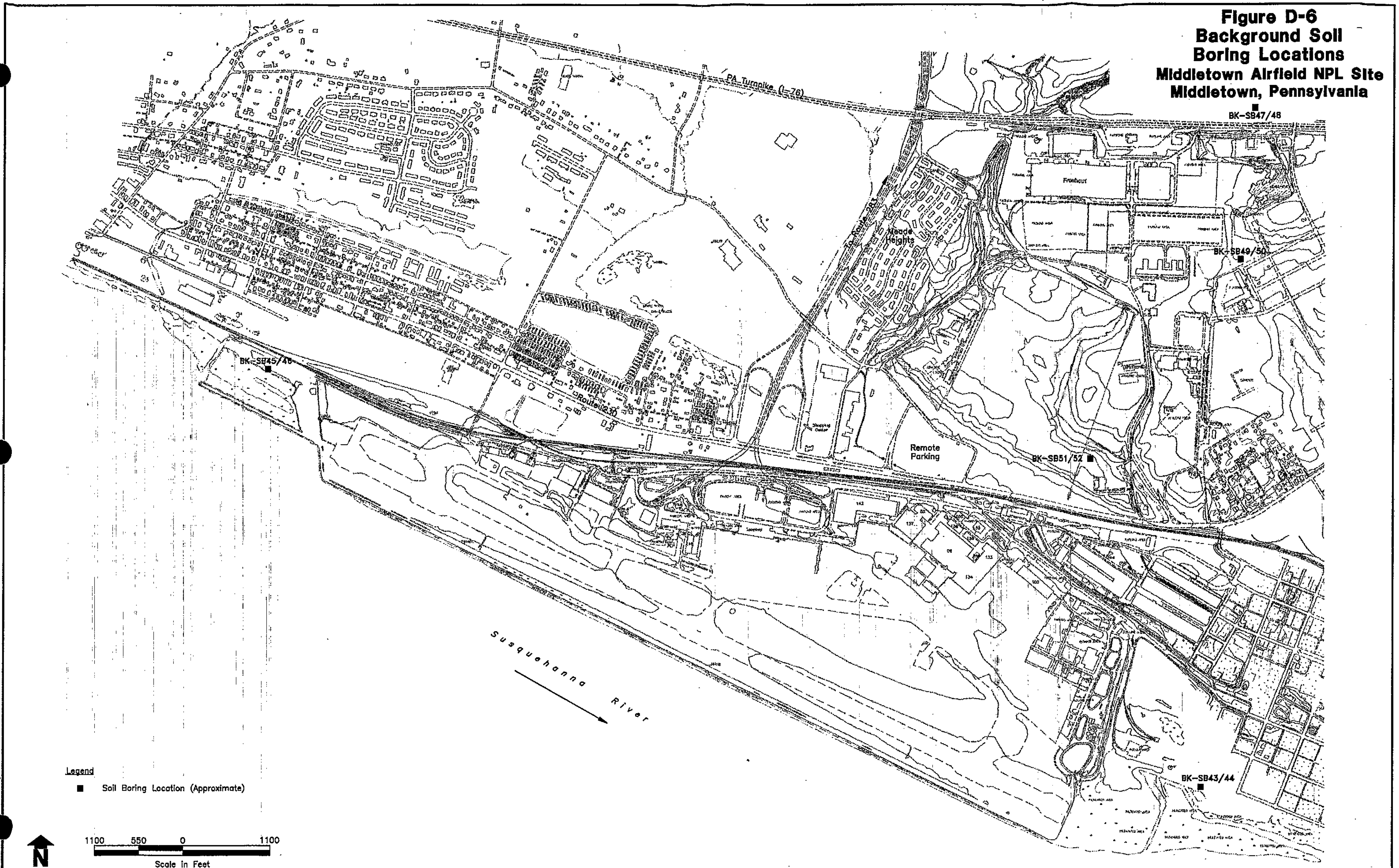
D.7.2 *Sample Designations and Analyses*

The soil borings in the Industrial Area were designated as follows:

- IAP-SB1 through IAP-SB10 for the borings along the pipelines in the Industrial Area;
- IAL-SB11 and IAL-SB12 for the borings in the Lagoon Area;
- IAB-SB13 through IAB-SB42 for the borings around the buildings in the Industrial Area;
- RA-SB53 through RA-SB57 for the borings in the Runway Area; and
- BK-SB43, BK-SB45, BK-SB47, BK-SB49, and BK-SB51 for the five background soil borings with BK-SB44, BK-SB46, BK-SB48, BK-SB50, and BK-SB52 for the co-located surface scrapes.

The samples collected from the borings were labeled with the appropriate prefix to designate the area of the Site and the boring number, followed by the depth interval. For example, a sample collected at a depth of 10 to 12 feet below grade from boring SB13 in the Industrial Area was designated IAB-SB13(10-12). Surface scrape samples collected from any of the boring locations were designated with "SSC" rather than the depth interval. For example, the surface scrape sample collected at boring location SB11 in the wastewater lagoon area was designated IAL-SB11(SSC).

Each of the soil samples from the Industrial Area, Lagoon Area, Runway Area, and Background borings was screened in the field by ERM-FAST® for the select VOCs and SVOCs. The samples were screened within 24 hours of submittal to allow timely selection of samples for off-site



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laboratory analysis, selection of remaining boring locations, and selection of monitoring well locations.

Three of five samples from each of the borings were selected for off-site laboratory analysis. Selection of sample intervals for laboratory analysis was based upon the following criteria applied to the ERM-FAST® screening results:

- the uppermost sample interval having a concentration of 10 µg/kg or greater for the target compounds,
- the first sample interval following the deepest interval having a concentration of 10 µg/kg or greater (but not below the water table), and
- the sample interval with the highest total concentration eluting from the GC within the retention time of the target compounds.

If screening did not detect any compounds, samples were selected for laboratory analysis based upon field judgment using the following criteria:

- sample interval was visually stained,
- sample interval exhibited a change in lithology, or
- sample interval was just above the water table.

The samples were analyzed by ERM-FAST® for TCL VOCs plus TICs and by an off-site laboratory for TCL SVOCs plus TICs, TCL Pesticides, TAL total metals, cyanide (total and amenable), total organic carbon (TOC) and cation exchange capacity (CEC). The surface scrape samples were not analyzed for VOCs. Surface scrape samples collected from borings IAL-SB11 and IAL-SB12 in the vicinity of the lagoons and borings IAB-SB14, -SB16, -SB17, -SB30, and -SB31 in the Main Building Area were also analyzed for TCL PCBs.

Geotechnical analyses were performed on two samples per boring in the pipeline areas. The geotechnical samples were analyzed for grain size distribution (ASTM D 421 and 422), Atterberg Limits (ASTM D 4318), and moisture content (ASTM D 2216).

D.8 STORM SEWER SEDIMENT SAMPLING

Sediment samples were collected from the storm sewer system in the Industrial Area to investigate whether contaminants were present in the system and determine their distribution through the system. The structural integrity of the storm sewers was visually evaluated in the immediate vicinity of manholes at the time of sampling.

Detailed mapping of the storm sewer system was obtained from existing facility maps titled Storm Drainage System, PA DOT, Bureau of Aviation, Olmsted Field, March 1977. These facility maps were used to identify the locations of points of entry for storm water into the sewer system, and the layout of the storm sewer network that ultimately discharges to the Susquehanna River. Flow direction was mapped during the walkover to confirm the flow directions noted on the facility maps and locate and inspect inlet locations. Several sample locations along the storm sewer lines required confined space entry per the procedures described in the Site Safety and Health Plan.

Samples were collected at the end of four outlets to the Susquehanna River and throughout the Main Building Area, downstream from locations where contaminants may enter the system, upgradient from suspected source areas, and along lines and line junctions to evaluate contamination distribution throughout the system. A total of 28 sediment samples were collected. Subsequent to this sampling, the USEPA performed sampling at five locations to confirm the previous ERM sampling and to better identify a potential source area. All sample locations are listed on Table D-3 and are plotted on Figure D-7. An enlargement of the Industrial Area showing the storm sewer sampling locations (e.g., including USEPA's sample locations) is provided on Figure D-7A.

D.8.1 *Techniques*

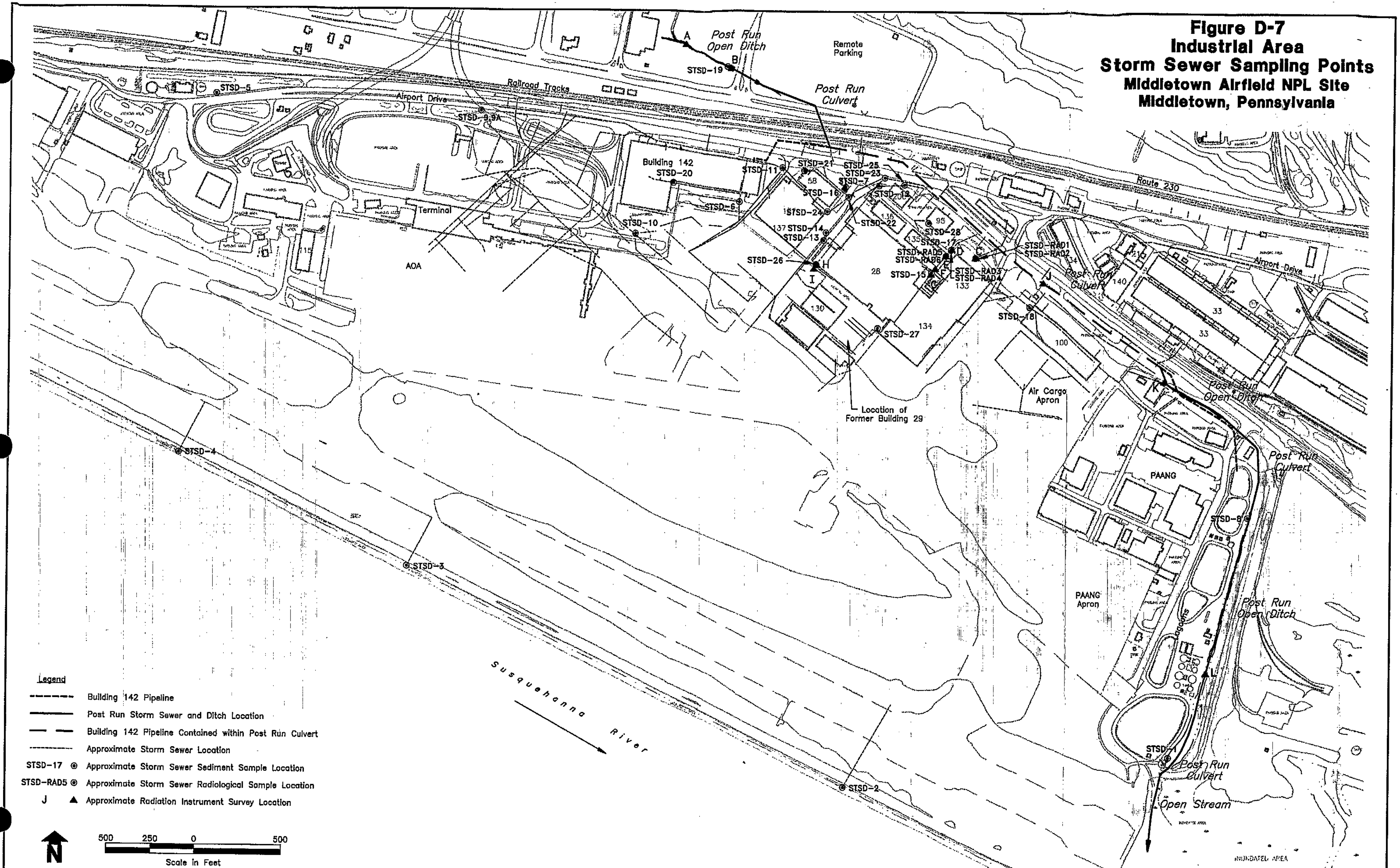
Sediment samples were collected from the furthest downstream location and proceeding upstream through the storm sewer system to minimize potential cross-contamination due to re-suspension of materials caused by sampling activities. The samples were not collected during or within 48 hours subsequent to a major rainfall event in order to minimize dilution and agitation effects from run-off and maximize potential for detecting VOCs in the sediment. A phased approach was used where an initial

Table D-3
Storm Sewer Sediment Sample Locations
Middletown Airfield NPL Site

Vault/Manhole #	Sample I.D.	Description
Post Run outfall	STSD-1	Just above outfall to river.
headwall F-1	STSD-2	At river outfall, drains from Runway Area.
headwall E-1	STSD-3	At river, drains from Bldg. 134.
headwall CD-1	STSD-4	At river outfall, drains from Terminal area.
vault on Airport Dr.	STSD-5	At HIA Water Treatment Plant.
vault D-55	STSD-6	South side Bldg. 142, drains from Bldg. 142.
vault J-52	STSD-7	Next to Bldg. 267, drains from Bldg. 267.
Post Run edge	STSD-8	As emerges from culvert northern lagoon area.
drain D-114	STSD-9	Under on-ramp, drains local area.
drain D-44	STSD-10	South side of Bldg. 142, drains pkg. lot.
vault J-45	STSD-11	East side Bldg. 142, drains from Bldg. 142.
vault J-5	STSD-12	West side Bldg. 208, drains Bldg. 28 garage.
drain J-14	STSD-13	Alley between Bldg. 28 and Bldg. 137.
drain J-34	STSD-14	Alley between Bldg. 28 and Bldg. 137
drain K-17	STSD-15	West of Bldg. 133, drains Bldgs. 28/134
vault J-51	STSD-16	Next to Bldg. 267, drains from Bldg. 267
vault K-3	STSD-17	West of Bldg. 133, drains Bldgs, 28/134/135.
vault L-4	STSD-18	West of Bldg. 100, drains locally.
Post Run edge	STSD-19	Upgradient of Industrial Area/HIA.
grease trap	STSD-20	Trap just south of Bldg. 142, drains Bldg. 142.
drain pipe at J-54	STSD-21	Pipe west of Bldg. 58, drains locally.
manhole J-38	STSD-22	East of Bldg. 58, drains Bldgs. 58/137 and 142.
manhole J-30	STSD-23	West of Bldg. 208, drains Bldgs. 58/137 and 142.
manhole J-40	STSD-24	West of Bldg. 28, drains Bldgs. 58/137 and 142.
vault J-2A	STSD-25	North of Bldg. 208, drains Bldgs. 28 and 130.
manhole J-11	STSD-26	South of Bldg. 28, drains 28 and alley.
drain K-27	STSD-27	North of Bldg. 28/134, drains locally.
drain K-10	STSD-28	South of Bldg. 95, drains locally.
drain J-5/STSD-12	by US EPA	West side Bldg. 208, drains Bldg. 28.
manhole J-6	by US EPA	In street south of Bldg. 208, drains Bldg. 28.
manhole J-7	by US EPA	Within Bldg. 28, drains auto shop area.
manhole J-8	by US EPA	In alley west of Bldg. 28, drains Bldg. 28.
drain J-12	by US EPA	In alley northwest of Bldg. 28, drains Bldg. 130.

Note: Drains locally means that the drain receives surface runoff only from its immediate area.
Sampled vaults are posted on Figure D-7, EPA sampled vaults posted on Figure D-7A.

Figure D-7
Industrial Area
Storm Sewer Sampling Points
Middletown Airfield NPL Site
Middletown, Pennsylvania



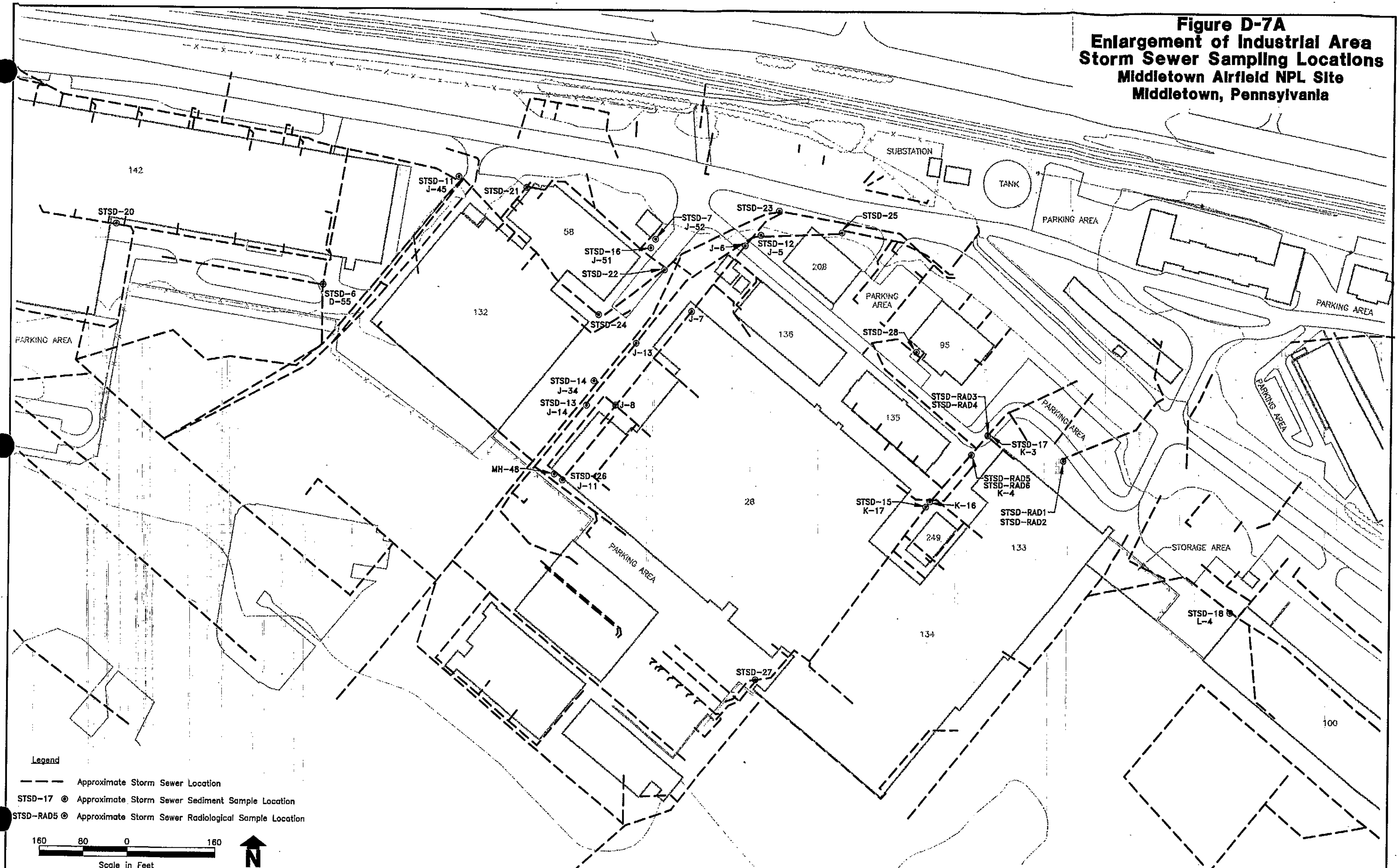


Figure D-7A
Enlargement of Industrial Area
Storm Sewer Sampling Locations
Middletown Airfield NPL Site
Middletown, Pennsylvania
SUBSTATION
TANK
PARKING AREA
STORAGE AREA
142
132
58
208
136
95
135
28
249
133
134
100
STSD-20
STSD-11
J-45
STSD-21
STSD-6
D-55
STSD-7
J-52
STSD-16
J-51
STSD-22
STSD-24
STSD-23
STSD-25
STSD-12
J-5
J-6
J-7
J-13
STSD-14
J-34
STSD-13
J-14
J-8
MH-48
STSD-26
J-11
STSD-28
STSD-RAD3
STSD-RAD4
STSD-17
K-3
STSD-RAD5
STSD-RAD6
K-4
STSD-15
K-17
K-16
STSD-RAD1
STSD-RAD2
STSD-18
L-4
STSD-27
Legend
Approximate Storm Sewer Location
STSD-17 Approximate Storm Sewer Sediment Sample Location
STSD-RAD5 Approximate Storm Sewer Radiological Sample Location
160 80 0 160
Scale in Feet
N

round of locations were sampled and the resulting analytical data examined, prior to selecting and sampling the remaining locations.

Sediment samples collected from within the storm sewer system were collected using a decontaminated stainless steel spoon. Samples for VOC analyses were placed directly into the sample containers. Bottles for the other analytical parameters were filled after sediment was composited and homogenized in a decontaminated stainless steel bowl. Sediment color, texture, and odor were noted upon sample collection and recorded in the samplers field notebook.

D.8.2 Sample Designations and Analyses

The storm sewer sediment samples were labeled with the prefix STSD followed by the location number 1 through 28. Sediment samples were analyzed by the off-site laboratory for the TCL VOCs plus TICs, TCL SVOCs plus TICs, TCL Pesticides and PCBs, TAL total metals, and cyanide (total and amenable). Sediment color, texture, and odor were noted upon sample collection and recorded in the samplers field notebook.

D.9 *RADIOLOGICAL SURVEY OF FORMER RADIUM DIAL PAINT SHOP*

Historical evidence indicated that a Radium Dial Paint Shop operated within the northeast corner of Building 135 during the 1940's and that a spill in that shop was cleaned up in the early 1950's. ERM performed a radiological instrument survey of the portion of Building 135 where the Radium Dial Paint Shop was located as well as storm sewer vaults in the vicinity that may have received drainage from the shop. This was done to determine whether radiological contaminants were present within the building and storm sewer, what their concentrations may be, and the distribution. The contaminant of concern is radium^{226} which is contained in radium dial paint. Aircraft radium dials were often sanded and repainted. As a result, fine paint dust has been known to be dispersed throughout the shop area.

An instrument survey was made of floors, walls, ceiling, windows, air ducts, and other areas within Building 135 where dust may have accumulated and remained undisturbed since the shop was in operation. A stairwell within Building 208 was also surveyed with the radiological instrumentation to establish background levels of radiation and allow a more accurate measure of levels seen within the area of interest. Wipe samples were to be collected from surfaces of the floors, walls, or other areas of the former paint shop in the event that elevated readings were detected. No elevated readings were noted, thus no analytical samples were collected from the rooms in Building 135 or from the background room in Building 208.

A total of eight vaults were surveyed with a radiation detection instrument because they either received storm sewer discharge directly from Building 135 and its immediate vicinity, or they provided information on background conditions within the storm sewers. Vaults K-3, K-4, and an unnamed vault on Post Run are downgradient from Building 135. Five other vaults were surveyed with the detection instrument to establish background radiation levels within the storm sewer system. An additional four locations on Post Run along the open ditch were measured upgradient from the site and downgradient from the Industrial Area. When levels above background were detected in Vaults K-3 and K-4, then sampling was performed at these two locations as well as from walls of a background vault. Surveyed and sample locations are listed on Table D-4 and presented on Figure D-7. An enlarged view is provided on Figure D-7A.

Table D-4

Radiation Survey and Wipe Sample Locations

Middletown Airfield NPL Site

Map Location ID #	Location name	Location Description
A	Unnamed location	On Post Run just south from Jamesway Plaza. side of stream. An upgradient location.
B	Unnamed location	On Post Run adjacent to Remote Parking lot.. side of stream. An upgradient location.
C	Unnamed vault (background sample)	Directly north of Building 133. This line is not connected to the other sampled sewer lines. Collected wipe samples: sampled N&W walls STSD-RAD1 sampled S&E walls STSD-RAD2
D	K-3 vault (samples)	East and downgradient from Bldg. 135. Collected wipe samples: sampled N&W walls STSD-RAD3 sampled S&E walls STSD-RAD4
E	K-4 vault (samples)	East and downgradient from Bldg. 135. Collected wipe samples: sampled N&W walls STSD-RAD5 w/QA/QC sampled S&E walls STSD-RAD6
F	K-16 vault	Located southeast and upgradient from Bldg. 135.
G	K-17 vault	Located southeast and upgradient from Bldg. 135.
H	J-11 vault	South side of Bldg. 28.
I	MH-48	Sanitary sewer vault next to J-11.
J	Unnamed vault	On Post Run adjacent to well ERM-28S. A downgradient location.
K	Unnamed location	On Post Run as it emerges from culvert at PAANG. side of stream. A downgradient location.
L	Unnamed location	On Post Run as it passes the HIA Sewer Treatment Plant. side of stream. A downgradient location.
	Ambient air background	Measured site wide above ground.

Note: Vaults were sampled with wipe samples on all four walls as noted above.

Surveyed and sampled vaults are plotted on Figure D-7 and D-7A.

In addition, ground water samples from selected wells upgradient and downgradient of the North Base Landfill were also submitted for Radium-226 analysis. This was done in an attempt to determine whether materials associated with operation of the former Radium Dial Paint Shop were placed in the North Base Landfill. The specific wells sampled were RFW-1, ERM-12S, ERM-12I, ERM-15I, and ERM-31I.

D.9.1 Techniques

The radiological instrument survey was performed using a Micro R Meter (Ludlum Model 19). The instrument was factory calibrated prior to use, with a source check performed in the field at the beginning and end of the day. This instrument measures primarily gamma radiation. The contaminant of concern is radium^{226}. As the element radium^{226} naturally decays, it emits alpha particles and has a half-life of approximately 1,600 years. Alpha particles are detectable over a very short distance (2 to 7 cm) and are easily masked by any sort of cover, even one as thin as paper. After 50 years, little if any of the original radium^{226} containing paint dust particles would remain exposed at the surface to be measured with an alpha detector. However, several of the decay daughters of radium^{226} are gamma emitters and can be readily monitored with instrumentation.

Wipe sampling of the storm sewer vaults was not performed during or within 48 hours subsequent to a major rainfall event to minimize dilution or agitation effects from run-off. The condition of the former Radium Dial Paint Shop and storm sewer vaults and levels detected during the radiological instrument survey were recorded into the field notebook. Filter paper was the sampling media used to wipe the walls of the storm sewer vaults. One filter paper was drawn along the walls over an area of approximately 70 square inches per wall or 150 square inches per sample. A duplicate sample was collected by wiping an equivalent area of the wall adjacent to where the original sample was collected.

D.9.2 Sample Designations and Analyses

No wipe samples were collected from the former radium dial paint shop as part of this survey. The storm sewer vault wipe samples were labeled with the prefix STSD, followed by RAD1 through RAD6. These samples were analyzed by the off-site laboratory for Radium 226 by EPA Method 903.1.

D.10 SURFACE WATER, SEDIMENT, AND BIOLOGICAL SAMPLING

Surface water, sediment, and biological samples were collected from the perennial stream at Meade Heights, and surface water and sediment samples were collected from the Susquehanna River to determine potential Site impacts, if any, to the water quality within the stream and river and the aquatic receptors inhabiting the stream.

Surface water and sediment samples were collected from four locations along the perennial stream at Meade Heights as shown on Figure D-8. One sample (MH-SED/SW-4) was collected upstream of the Pennsylvania Turnpike and represents background conditions. Two samples (MH-SED/SW-3 and MH-SED/SW-2) were collected adjacent to the Meade Heights residential area and the fourth sample (MH-SED/SW-1) was collected downstream of the Meade Heights residential area. Specific sampling locations were determined in the field during the sampling investigation. Descriptions of the sampling stations are provided on Table D-5.

Surface water and sediment samples were collected from the four locations along the Susquehanna River previously sampled during the Remedial Investigation (GF, 1990). The sample locations are also shown on Figure D-8. The objectives for sampling those locations were to characterize background conditions and assess the contribution, if any, from the Fire Training Pit, the landfill covered by the runway, discharge from the HIA storm sewer systems, and discharge from the lagoons. Table D-6 provides descriptions of the River sampling stations.

The approximate distances from permanent physical structures such as bridges and power lines were determined from each sampling station and recorded in the field notebook. In addition, a fluorescent painted stake with the station number was placed along the stream and river bank at each sampling location for future reference so that the sampling locations in the Susquehanna River can be duplicated during subsequent quarterly monitoring events. A distance and compass measurement was taken from each stake to the actual stream sampling location.

D.10.1 Surface Water and Sediment Sampling Techniques

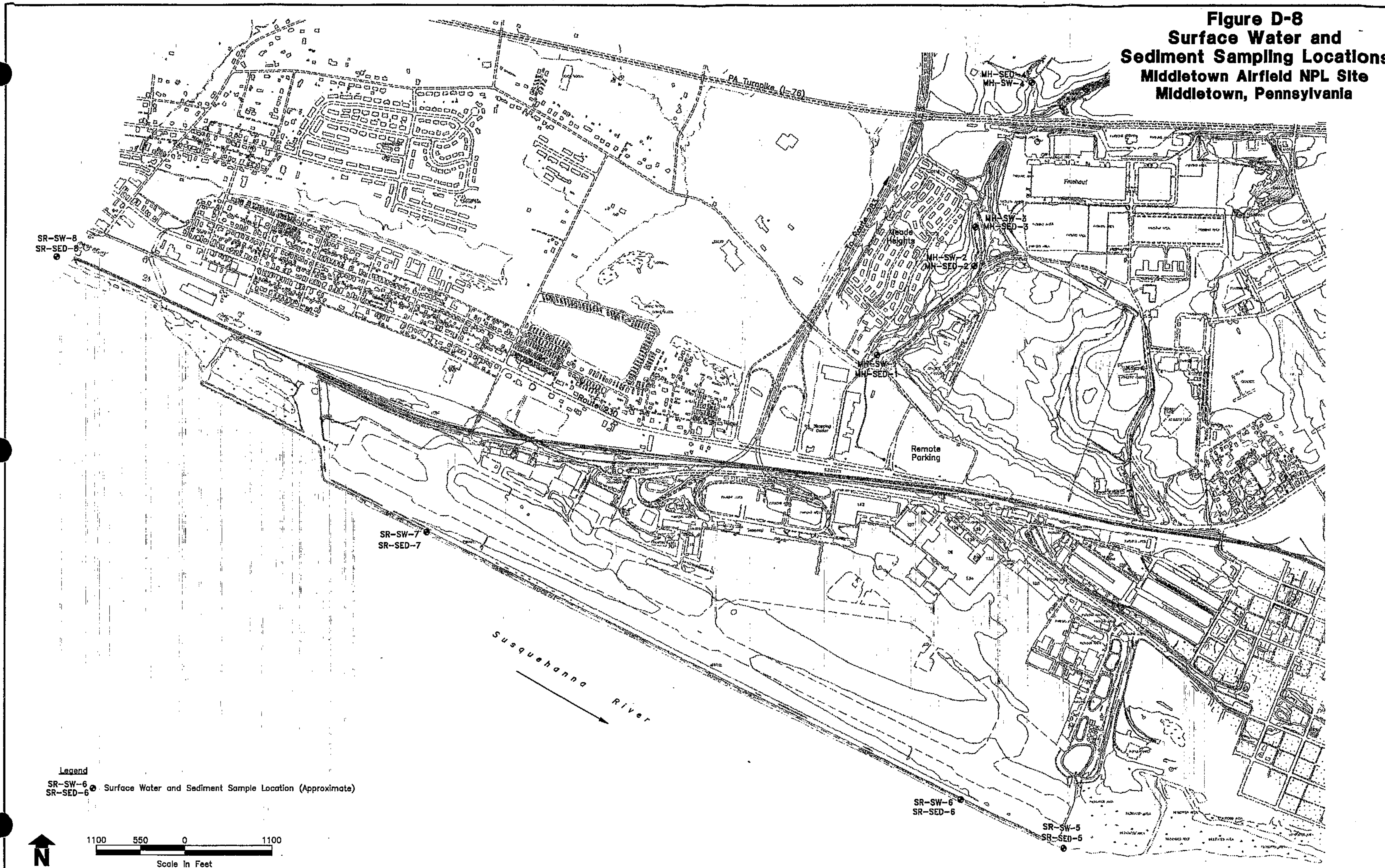
Surface water sampling was conducted from the furthest downstream station and proceeded to upstream stations to minimize potential cross-

Table D-5 Description of Meade Heights Sediment Sample Locations
Middletown Airfield NPL Site
Middletown, Pennsylvania
May 1994

Station Number	Location and Sediment Description
MH-1	Surface water and sediment samples were collected at the wooden staked location which was 150 feet upstream of Rosedale Ave and approximately 75 feet upstream of a sewer crossing. Sediments were red-brown silty fine sand with limited vegetation. Sediments had no odor and no sheen when disturbed. Sediments were collected from the middle and eastern side of the creek just downstream of a riffle area. The creek at this station had steep eroded banks, was about 5 feet wide and the water depth was 2 to 4 inches. Grain size analysis: 1 % gravel, 92 % sand, 7 % silt/clay.
MH-2	The wooden stake was located about 1,700 feet upstream of Station MH-1. Surface water and sediment samples were collected about 5 feet from the staked location. A small tributary from the east enters Meade Heights Creek just upstream of the staked location. Sediments were red-brown silty fine sand with limited vegetation. Sediments had no odor and no sheen when disturbed. Sediments were collected from the delta area where the eastern tributary enters the main creek. The creek at this station had steep eroded banks, was about 5 feet wide and the water depth was 2 to 3 inches. Grain size analysis: 0 % gravel, 94 % sand, 6 % silt,/clay.
MH-3	The wooden stake was located about 500 feet upstream of Station MH-2 and 30 feet downstream from where the creek exits a 12 foot corrugated pipe. The creek flows through this pipe for about 350 feet upstream of this station. Surface water and sediment samples were collected from the creek 30 feet downstream of the pipe. Sediments were brown clayey silt with some fine sand and limited vegetation. Sediments had no odor but had a slight sheen when disturbed. The creek bed at this station is about 20 feet wide; however the creek splits into two branches and flows around a sandy island which measured about 15 feet by 8 feet. Samples were collected from the western branch which was about 3 feet wide and the water depth was 2 to 6 inches. The creek at this station had steep eroded banks. Grain size analysis: 1 % gravel, 70 % sand, 29 % silt/clay.

Table D-5 Description of Meade Heights Sediment Sample Locations
Middletown Airfield NPL Site
Middletown, Pennsylvania
May 1994

Station Number	Location and Sediment Description
MH-4	The wooden stake was located on the eastern branch of the main creek about 450 feet upstream (north) of the Pennsylvania Turnpike. Surface water and sediment samples were collected from the eastern branch approximately 75 feet downstream from a private road crossing. Sediments were red-brown silty fine sand with some medium sand and limited vegetation. Sediments had no odor and no sheen when disturbed. Sediments were collected from the northeastern side of the stream, just southwest of the staked location. The creek at this station had short steep eroded banks, was about 3 feet wide and the water depth was 1 to 2 inches. Grain size analysis: 1 % gravel, 86 % sand, 13 % silt/clay.



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PM008.07.01/06.14.96-MKB/I210 -2B

Table D-6 Description of Susquehanna River Sediment Sample Locations, Collected on 26, 27 May 1994
Middletown Airfield NPL Site
Middletown, Pennsylvania

Station Number	Location and Sediment Description
SR-5 (Downstream)	Surface water and sediment samples were collected at the staked location about 90 feet south (downstream) from the base of the south end of the runway slope. Sediments were brown-black silty muck with some fine to medium sand and limited vegetation. Sediments had an H_2S odor and a sheen when disturbed. Sediments were collected within 4 to 8 inches of water and within 10 feet of the shoreline. The top 2 to 3 inches of sediment were collected, below 3 inches was course gravel. Grain size analysis: 1% Gravel, 46% Sand, 53% Silt/Clay.
SR-6 (Adjacent)	Surface water and sediment samples were collected at the staked location about 30 feet south (downstream) of the first storm sewer flap gate from the south end of the airport runway. Storm water from the airport is discharged through this flap gate. Sediments were brown-black silty muck with some light brown fine to medium sand and limited vegetation. Sediments had a slight H_2S odor and a sheen when disturbed. Sediments were collected within 4 to 6 inches of water and within 5 feet of the shoreline. The top 2 to 3 inches of sediment were collected, below 3 inches were gravel and boulders. Grain size analysis: 0% Gravel, 58% Sand, 42% Silt/Clay.
SR-7 (Adjacent)	Surface water and sediment samples were collected at the staked location about 50 feet south (downstream) of the pipeline which crosses the Susquehanna River near the northern portion of the runway. The pipeline is marked by a long orange pole and sign near the top of the runway berm. Sediments were dark brown-black silty muck with some light brown fine sand and limited vegetation. Sediments had a slight H_2S odor but no sheen when disturbed. Sediments were collected within 4 to 6 inches of water and within 5 feet of the shoreline. The top 2 to 3 inches of sediment were collected, below 3 inches was gravel. Grain size analysis: 0% Gravel, 68% Sand, 32% Silt/Clay.

Table D-6 Description of Susquehanna River Sediment Sample Locations Collected on 26, 27 May 1994 (Continued) USACE - Middletown Airfield Harrisburg, Pennsylvania

Station Number	Location and Sediment Description
SR-8 (Upstream)	Surface water and sediment samples were collected at the staked location north (upstream) of the airport. The station is located about half way between the northern most tip of the airport runway and the PA turnpike. Also the station is located just upstream of a sewage treatment plant and about 600 feet upstream from a private boat launch. Sediments were dark brown silty muck with some fine sand and some decomposed vegetation. Sediments had a strong H_2S odor and a moderate sheen when disturbed. Sediments were collected within 6 to 10 inches of water and within 10 feet of the shoreline. The top 3 to 4 inches of sediment were collected. Grain size analysis: 0% Gravel, 48% Sand, 52% Silt/Clay.

contamination due to the re-suspension of materials in the sediment caused by sampling activities. In addition, surface water samples were collected before stream sediments and biological samples to minimize cross-contamination. The water samples were collected by immersing a laboratory clean glass jar below the surface of the water and transferring the water to the appropriate sample container. Samples were collected in this manner so that the preservatives in the sample bottles were not lost during sampling. A separate clean glass jar was used at each station to eliminate cross-contamination. Samples were collected from the middle of the perennial stream and along the northern side of the Susquehanna River, depending on the depth.

Stream and river sediments were collected from depositional areas to assure that areas with the greatest potential for contaminant accumulation were sampled. Generally, samples were collected using a decontaminated stainless steel trowel. If ample sediment was available and the water column above the sediment at the sample location was flowing or greater than 4 inches in depth, a sediment core sampling device was used to collect the sample to minimize washing of the sediment as it was retrieved. Standing water from the top of the core sampler was decanted off prior to withdrawing the sediment. In all cases, a decontaminated stainless steel trowel was used to transfer the sample into the stainless steel bowl or directly into the sample containers. For VOC analyses, the sediment was placed directly from the corer into the sample container. For all other analyses, stream and river sediments were placed into a decontaminated stainless steel bowl, homogenized using a stainless steel trowel, then transferred into the appropriate sample containers.

D.10.2 Sample Designations and Analyses

Surface water and sediment sample locations were labeled with the prefix "MH" to indicate the stream at Meade Heights or "SR" to indicate the Susquehanna River locations. The sampling stations were designated as follows:

- MH-SW1 through MH-SW4 and MH-SED1 through MH-SED4, to designate the Meade Heights surface water and sediment samples, respectively; and
- SR-SW5 through SR-SW8 and SR-SED5 through SR-SED8, to designate the Susquehanna River surface water and sediment samples, respectively.

Surface water and sediment samples were both analyzed by the off site laboratory for TCL VOCs plus TICs, TCL SVOCs plus TICs, TCL pesticides, TCL PCBs, TAL total metals and cyanide (total and amenable). In addition, surface water was analyzed for water quality parameters including hardness, alkalinity, total dissolved solids (TDS), conductivity, pH, temperature and dissolved oxygen. Sediment was also analyzed for geochemical parameters, including pH, total organic carbon (TOC), moisture content, cation exchange capacity (CEC), and grain size. Field water quality parameters such as pH, dissolved oxygen, specific conductivity, and temperature were measured in-situ at each sampling station. An assessment of water color, odor, and turbidity was made upon collection of all surface water samples, and recorded in the field notebook.

D.10.3 *Biological Sampling*

Macroinvertebrates and fish were collected at four locations along the perennial stream at Meade Heights in the vicinity of the surface water and sediment sampling stations. Specific sampling locations were determined in the field based on habitat quality. A detailed report of the Meade Heights stream survey is provided in Appendix G.

D.10.3.1 *Fish Characterization*

A quantitative characterization of the fish community structure at each station along the perennial stream was conducted according to Protocol V (RBP V) as described in the Rapid Bioassessment Protocols For Use in Streams and Rivers (US EPA/444/4-89-001). Sampling methods also followed guidelines documented in Fish Field and Laboratory Methods for Evaluating the Biological Integrity of Surface Waters (US EPA/600/R-92/111). General methods are described below.

Fish were collected by electroshocking a predetermined stream section (generally 100 to 300 meters in length) at each station. Block nets were placed in the stream at the upstream and downstream ends of the stream section so the fish did not escape capture. Large fish collected were identified, counted, measured, weighed, and then released back into the stream. Smaller fish were preserved in a 10% formalin solution and transported to ERM's taxonomic lab where they were identified, measured, weighed, and enumerated. Each fish was examined for external tumors or lesions and noted in the field notebook. Each stream section per station included at least one riffle, run, and pool, if possible, so that the all varieties of fish species present could be collected.

An assessment of the stream habitat was conducted according to the Rapid Bioassessment Protocol. This assessment characterizes parameters such as bottom substrate, cover, embeddedness, flow, channel alteration, bottom scouring, deposition, bank stability, bank vegetation, and streamside cover.

Potential impacts to the fish community from contaminants of concern were evaluated by comparing the diversity and abundance of fish collected from the adjacent and downstream stations to the diversity and abundance of fish collected from the background station. In addition, data analyses will follow the procedures specified in the Rapid Bioassessment Protocols For Use in Streams and Rivers (US EPA/444/4-89-001).

D.10.3.2 *Macroinvertebrate Characterization*

The assessment of the macroinvertebrate community was conducted according to Protocol III (RBP III) as described in the Rapid Bioassessment Protocols For Use in Streams and Rivers (US EPA/444/4-89-001). Field sampling methods also followed guidelines described in Macroinvertebrate Field and Laboratory Methods for Evaluating the Biological Integrity of Surface Waters (US EPA/600/4-90-030).

In accordance with the RBP III, a representative sample of the macroinvertebrate fauna at each station was collected from the riffle/run habitat and supplemented with the collection of a Coarse Particulate Organic Material (CPOM) sample. CPOM exists in the form of plant debris (leaves, needles, twigs, and bark) which accumulates in depositional areas. Macroinvertebrate sampling at each station consisted of two 10 second kick net samples collected from an area of approximately 1 m^2 within the riffle/run habitat. At least 100 organisms were randomly picked off the net from each sample then composited into one sample for each station. In addition to the riffle/run sample, a CPOM sample was collected by taking several handfuls of partially decomposed leaf packs, twigs, or bark and compositing them into one sample for each station. All samples were labeled with the appropriate station number and preserved in alcohol. These samples were transported to ERM's taxonomic laboratory for identification and enumeration. Sample sorting followed the procedures outlined in the RBP III, and collected organisms were counted and identified to the lowest possible taxonomic level (generally Genus).

Data analysis techniques followed the procedures outlined in RBP III. Eight metrics were calculated based on the raw macroinvertebrate data.

These metrics include taxa richness, biotic index, ratio of scrapers to filtering collectors, ratio of EPT to chironomidae abundances, percent contribution of dominant taxon, EPT index, community similarity indices, and ratio of shredder functional feeding group to total number of individuals collected. Stations located adjacent to and downstream of the Site were compared to the upstream (background) station to determine if the macroinvertebrate community was being impacted.

D.10.3.3 *Sample Designations*

The biological sampling locations were labeled with the prefix MH-BIO to indicate a biological sample from the stream at Meade Heights. The samples were then given the same location number as the nearest surface water/sediment location, followed by the letter "f" for fish samples or "m" for macroinvertebrate samples. For example, a fish sample collected from near the MH-SW1 location was designated MH-BIO1f.

An aquatic survey of the river was planned if results from surface water and sediment sampling identified the presence of site-related contaminants exceeding appropriate documented levels. This survey was subsequently deemed to be unnecessary and was not performed.

D.11 WELL INSTALLATION

Various types and depths of monitoring wells were installed in several areas of the Site. These wells were used to delineate plumes in the ground water, further define contaminant source areas, and serve as observation points for evaluation of the overburden and bedrock aquifers as part of aquifer testing. ERM's subcontractor for the drilling of the shallow well borings and the installation of these monitoring wells was Aquifer Drilling and Testing - Mid Atlantic (ADT-MA) of Trenton, NJ. ERM's subcontractor for the bedrock drilling, video logging services, intermediate and deep well installation, well development, and bulk on-site handling of Investigation Derived Wastes (IDW) was Hydro Group, Inc. of Meadeville, PA.

Monitoring wells installed during this investigation were designated with the prefix "ERM" to avoid confusion with the existing monitoring wells at the Site. Wells which were installed in clusters will have the same number followed by a letter which designates the well as shallow ("S"), intermediate ("I"), or deep ("D"). The designations for the wells in each area are presented on Table D-7.

Monitoring wells installed at the Site included overburden wells, and shallow, intermediate, and deep bedrock wells. All wells were logged and installed according to USACE guidelines. The drilling procedures and the well construction specifications for the various wells are described in the following sections. Monitoring well construction details for overburden and bedrock wells installed as part of the SSI are presented in Table D-8, and for production wells on Table D-9. The monitoring wells and production wells were surveyed by a licensed surveyor, Rettew Associates, Inc. of Lancaster, PA, for ground surface elevations, top of casing elevations, and horizontal locations The well locations are plotted on Figures D-9A through D-9C.

D.11.1 Shallow Wells

Overburden monitoring wells were drilled using HSA drilling techniques and reached a depth of approximately 15 to 25 feet below land surface (bls). When the shallow wells were completed in bedrock, the overburden was generally drilled using HSA drilling, with the rock interval being drilled out using conventional air rotary with a tricone roller bit. These shallow wells generally reached depths of approximately 35 feet bgs.

Table D-7
Listing of Monitoring Wells Installed During the Supplemental Studies Investigation by Area Middletown Airfield NPL Site

Industrial Area Wells	Building 142 Pipeline Wells	Lagoon Wells	Capture Zone Wells	Runway Area Wells	North Base Landfill Wells	Sentinel Wells
ERM-4S	ERM-2S	ERM-1S	ERM-21S	ERM-18S	ERM-11S	ERM-7S(SENT)
ERM-5S	ERM-3S	ERM-1I	ERM-21I	ERM-18I	ERM-11I	ERM-7I(SENT)
ERM-10I	ERM-6S		ERM-21D			ERM-7D(SENT)
ERM-27S	ERM-28S			ERM-19S	ERM-12S	
			ERM-22S		ERM-12I	ERM-8S(SENT)
ERM-32I			ERM-22I	ERM-20S		ERM-8I(SENT)
ERM32D			ERM-22D	ERM-20I	ERM-13S	ERM-8D(SENT)
					ERM-13I	
ERM-33I			ERM-23S			ERM-9S(SENT)
			ERM-23I		ERM-14S	ERM-9I(SENT)
ERM-34S			ERM-23D		ERM-14I	ERM-9D(SENT)
ERM-34I						
			ERM-24S		ERM-15I	
ERM-35S			ERM-24I			
ERM-35I			ERM-24D		ERM-16S	
					ERM-16I	
			ERM-25S			
			ERM-25I		ERM-17S	
			ERM-25D		ERM-17I	
			ERM-26S		ERM-29S	
			ERM-26I		ERM-29I	
			ERM-26D			
					ERM-30S	
					ERM-30I	
					ERM-31I	

S = Shallow
I = Intermediate
D = Deep
SENT = Sentinel Wells

Note: Well locations are plotted on Figures D-9A, D-9B, and D-9C.

Table D-8
Well Construction Details
Middletown Airfield NPL Site

Location of Well	Well I.D.	PA State Grid Coordinates Northing (Y)	Easting (X)	Elevation Top of Casing (MSL)	Land Surface Elevation (MSL)	Well Depth (feet BLS)	OB/ BR Well	Sand Pack Interval (feet BLS)	Screen Inverval (feet BLS)	Well Diamter/ Material (in.)	
Main	ERM-1S	314378.286	2249355.178	295.22	295.61	13.46	OB	2.5-15.0	3.0-13.0	2	pvc
Building	ERM-1I	314344.186	2249365.167	294.96	295.23	98.65	BR	74.0-99.7	78.58-98.58	2	pvc
/Lagoon	ERM-2S	316176.579	2247768.215	298.29	298.74	16.86	OB	6.0-18.5	8.0 - 18.0	2	pvc
Area Wells	ERM-3S	316445.448	2247133.293	300.96	301.27	16.58	OB	6.0-22.0	7.0 - 17.0	2	pvc
	ERM-4S	316330.819	2246957.705	299.57	299.88	19.60	OB	7.0-19.5	9.0-19.0	2	pvc
	ERM-5S	316147.920	2247207.383	297.26	297.85	19.35	OB	8.0-20.5	10.0-20.0	2	pvc
	ERM-6S	316441.710	2246844.150	302.36	303.09	23.50	OB	12.5-25.0	14.5 -24.5	2	pvc
	ERM-10I	316144.025	2245931.468	301.00	301.30	99.85	BR	78.0-102.0	80.0-100.0	2	pvc
	ERM-27S	315859.981	2246901.946	300.93	298.43	22.76	OB	7.5-20.0	9.5 - 19.5	2	pvc
	ERM-28S	315761.841	2248309.090	298.55	299.29	21.45	BR	9.5-22.0	11.5-21.5	2	pvc
	ERM-32I	315945.980	2247069.883	297.31	297.54	100.10	BR	77.5-102.5	80.0-100.0	2	pvc
	ERM-32D	315954.245	2247076.989	297.25	297.55	300.00	BR	276.0-302.0	280.0-300.0	4	pvc
	ERM-33I	315819.038	2247796.296	297.09	297.47	131.89	BR	107.0-142.0	112.0-132.0	2	pvc
	ERM-34S	314672.408	2248431.190	297.07	297.45	17.50	OB	6.0-19.25	8.2-18.2	2	pvc
	ERM-34I	314685.336	2248438.721	297.06	297.42	99.90	BR	77.0-102.0	80.0-100.0	2	pvc
	ERM-35S	313534.168	2248575.260	299.33	299.57	19.37	OB	7.0-20.5	9.5-19.5	2	pvc
	ERM-35I	313519.399	2248593.370	299.04	299.39	99.78	BR	77.4-102.0	80.0-100.0	2	pvc
Capture	ERM-21S	316045.223	2244344.825	303.44	303.79	34.83	BR	24.0-36.0	25.5-35.5	2	pvc
Zone	ERM-21I	316000.455	2244326.514	303.08	303.30	199.76	BR	155.0-202.0	160.0-200.0	4	SS
Wells	ERM-21D	316022.951	2244333.713	303.23	303.53	599.17	BR	552.0-603.0	557-597	4	SS
	ERM-22S	316096.643	2244163.645	308.37	308.63	43.07	BR	31.0-44.2	33.5-43.5	2	pvc
	ERM-22I	316144.473	2244186.030	309.21	309.47	199.47	BR	157.0-202.0	160.0-200.0	4	SS
	ERM-22D	316131.586	2244168.720	308.41	308.68	599.13	BR	552.0-603.0	557.0-597.0	4	SS
	ERM-23S	316159.331	2246605.563	301.47	301.66	24.44	OB	13.0-26.0	15.0-25.0	2	pvc
	ERM-23I	316163.826	2246592.153	301.45	301.74	196.58	BR	149.0-200.0	155.0-195.0	4	SS

Table D-8
Well Construction Details
Middletown Airfield NPL Site

Location of Well	Well I.D.	PA State Grid Coordinates Northing (Y)	Easting (X)	Elevation Top of Casing (MSL)	Land Surface Elevation (MSL)	Well Depth (feet BLS)	OB/ BR Well	Sand Pack Interval (feet BLS)	Screen Inverval (feet BLS)	Well Diamter/ Material (in.)	
	ERM-23D	316156.299	2246617.995	301.70	301.83	593.59	BR	547.0-602.0	553.0-593.0	4	SS
	ERM-24S	316106.946	2246713.362	299.97	300.27	24.39	OB	12.1-25.0	14.7-24.7	2	pvc
	ERM-24I	316139.375	2246723.309	300.05	300.40	199.07	BR	157.0-202.0	160.0-200.0	4	SS
	ERM-24D	316126.382	2246712.314	300.12	300.38	598.85	BR	553.0-603.0	557-597	4	SS
	ERM-25S	315974.625	2249256.845	330.04	330.39	45.45	BR	32.9-48.1	36.2-46.2	2	pvc
	ERM-25I	315977.872	2249244.097	330.20	330.40	189.91	BR	157.0-202.0	160.0-200.0	4	SS
	ERM-25D	315981.387	2249230.161	330.16	330.50	599.19	BR	553.0-603.0	558.0-598.0	4	SS
	ERM-26S	315840.197	2249223.525	331.25	331.53	45.97	BR	34.0-46.3	36.0-46.0	2	pvc
	ERM-26I	315847.957	2249212.164	331.28	331.51	200.06	BR	157.0-202.0	160.0-200.0	4	SS
	ERM-26D	315829.719	2249236.334	331.11	331.35	599.92	BR	556.0-602.0	560.0-600.0	4	SS
Runway	ERM-18S	315338.485	2246180.109	301.98	302.50	19.72	OB	8.0-21.0	10.5 - 20.5	2	pvc
Wells	ERM-18I	315348.706	2246154.608	302.18	302.41	120.22	BR	97.0-122.5	100.0-120.0	2	pvc
	ERM-19S	314014.853	2247842.987	299.72	300.11	18.79	OB	6.8-19.5	9.0-19.0	2	pvc
	ERM-20S	312837.385	2247694.238	301.11	301.37	25.37	OB	13.0-26.0	15.8 - 25.8	2	pvc
	ERM-20I	312844.821	2247680.220	301.04	301.31	119.80	BR	97.0-123.0	100.0-120.0	2	pvc
North	ERM-11S	319385.531	2250412.001	368.73	368.92	24.69	BR	13.0-25.5	15.0 - 25.0	2	pvc
Base	ERM-11I	319443.928	2250416.283	370.34	370.67	99.79	BR	77.0-101.0	80.0-100.0	2	pvc
Landfill	ERM-12S	319688.795	2250869.015	379.40	379.67	20.61	BR	9.0-22.0	11.0-21.0	2	pvc
Wells	ERM-12I	319634.279	2250863.556	379.17	379.36	100.12	BR	75.5-102.0	80.0-100.0	2	pvc
	ERM-13S	320360.861	2250280.590	383.12	383.38	21.62	BR	20.0-33.5	22.0-32.0	2	pvc
	ERM-13I	320348.327	2250282.801	382.98	383.22	101.25	BR	75.0-102.0	80.0-100.0	2	pvc
	ERM-14S	320612.957	2250297.620	384.08	384.41	33.00	BR	20.0-34.5	23.5-33.5	2	pvc
	ERM-14I	320627.333	2250294.716	384.82	385.04	107.70	BR	76.5-102.0	80.0-100.0	2	pvc
	ERM-15I	321210.093	2250833.489	399.15	399.50	99.70	BR	75.0-102.0	80.0-100.0	2	pvc

Table D-8
Well Construction Details
Middletown Airfield NPL Site

Location of Well	Well I.D.	PA State Grid Coordinates Northing (Y)	Easting (X)	Elevation Top of Casing (MSL)	Land Surface Elevation (MSL)	Well Depth (feet BLS)	OB/ BR Well	Sand Pack Interval (feet BLS)	Screen Inverval (feet BLS)	Well Diamter/ Material (in.)	
	ERM-16S	319947.658	2249389.440	377.33	377.59	43.97	BR	30.0-46.0	34.0-44.0	2	pvc
	ERM-16I	319932.282	2249388.275	377.24	377.49	101.14	BR	76.0-102.0	80.0-100.0	2	pvc
	ERM-17S	319963.100	2248544.060	377.22	377.56	44.59	BR	31.0-46.0	35.0-45.0	2	pvc
	ERM-17I	319962.544	2248560.343	377.31	377.54	101.17	BR	78.0-102.0	80.0-100.0	2	pvc
	ERM-29S	319540.511	2248395.300	376.53	376.82	45.16	BR	32.5-46.0	34.5-44.5	2	pvc
	ERM-29I	319548.278	2248389.370	376.61	376.96	99.78	BR	76.0-102.0	80.0-100.0	2	pvc
	ERM-30S	319247.863	2249399.930	366.73	367.01	19.53	BR	8.0-21.5	10.0-20.0	2	pvc
	ERM-30I	319246.277	2249416.060	366.84	367.06	100.10	BR	76.0-102.0	80.0-100.0	2	pvc
	ERM-31I	319796.530	2250820.520	377.99	378.40	200.32	BR	176.5-202.0	180.0-200.0	2	pvc
Sentinel Wells	ERM-7S(SENT)	320642.631	2251571.913	408.03	408.39	146.72	BR	120.0-152.0	123.0-143.0	4	SS
	ERM-7I(SENT)	320663.135	2251560.205	408.46	408.74	333.71	BR	288.0-352.0	294.0-334.0	4	SS
	ERM-7D(SENT)	320683.756	2251548.749	409.62	409.99	643.35	BR	594.0-678.5	603.0-643.0	4	SS
	ERM-8S(SENT)	320459.607	2251643.771	409.69	409.96	124.57	BR	102.0-130.0	105.0-125.0	4	SS
	ERM-8I(SENT)	320475.911	2251638.523	409.24	409.50	343.80	BR	295.5-352.0	302.0-342.0	4	SS
	ERM-8D(SENT)	320492.084	2251634.125	408.61	409.19	643.95	BR	628.0-678.0	632.0-672.0	4	SS
	ERM-9S(SENT)	320536.061	2251952.437	419.99	420.27	144.29	BR	121.0-152.0	125.0-145.0	4	SS
	ERM-9I(SENT)	320519.446	2251946.541	420.51	420.83	348.22	BR	302.0-352.0	310.0-350.0	4	SS
	ERM-9D(SENT)	320517.279	2251930.144	421.16	421.46	670.91	BR	625.0-677.0	630.0-670.0	4	SS

Note * **The reference point for the top of casing measurements for the production wells is the top of a mounting bolt on the pump.**

BLS = **below land surface**
MSL = **Mean Sea Level**
BR = **Bedrock**
OB = **Overburden**

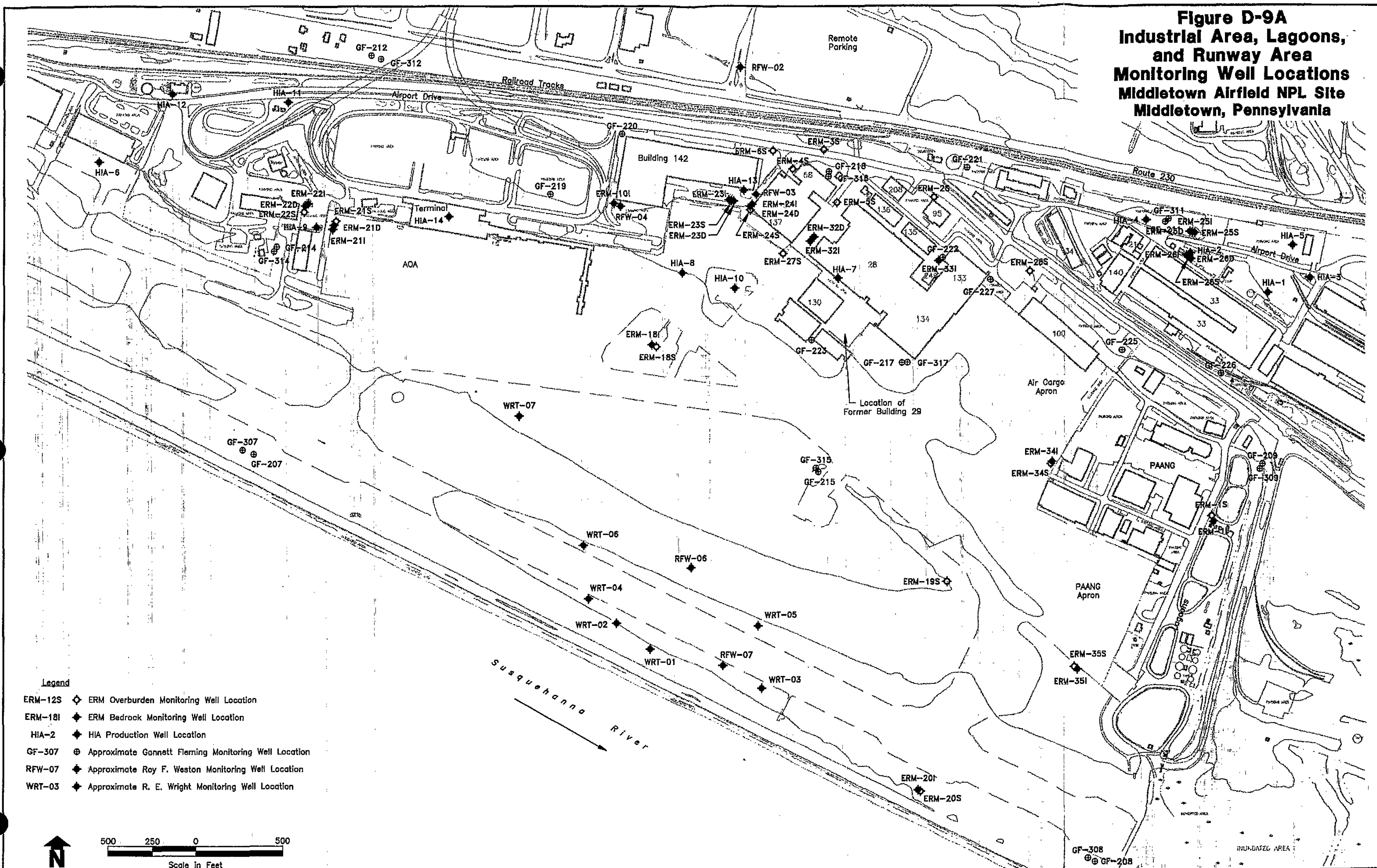
Table D-9
Production Well Construction Details
Middletown Airfield NPL Site

Location of Well	Well I.D.	PA State Grid Coordinates Northing (Y)	Easting (X)	Elevation Top of Casing (MSL)	Borehole Diameter (in)	Well Depth (feet BLS)	OB/ BR Well	Casing Depth (feet BLS)	Open Borehole Interval (feet BLS)	Pump Depth (feet BLS)
Production Wells	HIA-1	315808.522	2249479.870	324.32	10	629	BR	104	104-629	250
	HIA-2	315899.836	2249167.950	325.92	10	450	BR	100	100-450	250
	HIA-3	315742.706	2249774.960	320.21	10	450	BR	100	100-450	250
	HIA-4	316121.998	2248940.480	325.05	10	140	BR	100	100-140	140
	HIA-5	316013.728	2249771.680	320.65	10	450	BR	100	100-450	140
	HIA-6	316334.212	2243025.610	296.15	NA	500	BR	200	200-500	180
	HIA-9	316001.759	2244243.550	309.32	10	450	BR	101	101-450	140
	HIA-11	316675.868	2244041.040	307.07	10	603	BR	75	75-603	250
	HIA-12	316756.938	2243381.870	301.00	10	603	BR	75	75-603	210
	HIA-13	316218.167	2246681.520	304.99	10	602	BR	75	75-602	350
	MID-04	320778.010	2252147.080	414.05	10	815	BR	50	50-815	400

Note * The reference point for the top of casing measurements for the HIA and MID production wells is the top of a mounting bolt on the pump.

BLS = Below land surface
MSL = Mean Sea Level
BR = Bedrock
OB = Overburden
NA = Not Available

Figure D-9A
Industrial Area, Lagoons, and Runway Area Monitoring Well Locations
Middletown Airfield NPL Site
Middletown, Pennsylvania



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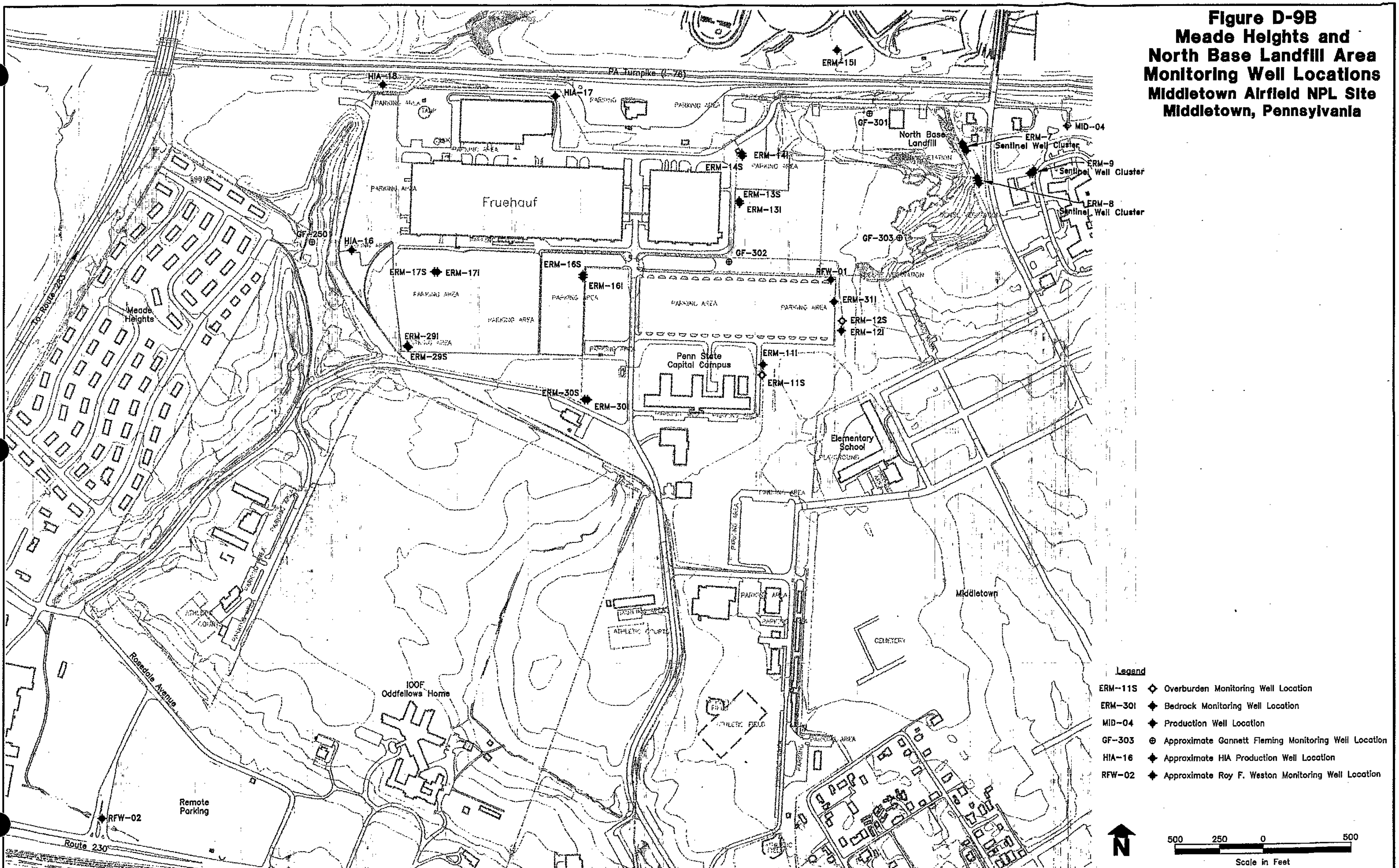
PM008.07.01/05.17.96-MKB/06.14.96-MKB/I202 -3B

Figure D-9B
Meade Heights and North Base Landfill Area Monitoring Well Locations
Middletown Airfield NPL Site
Middletown, Pennsylvania



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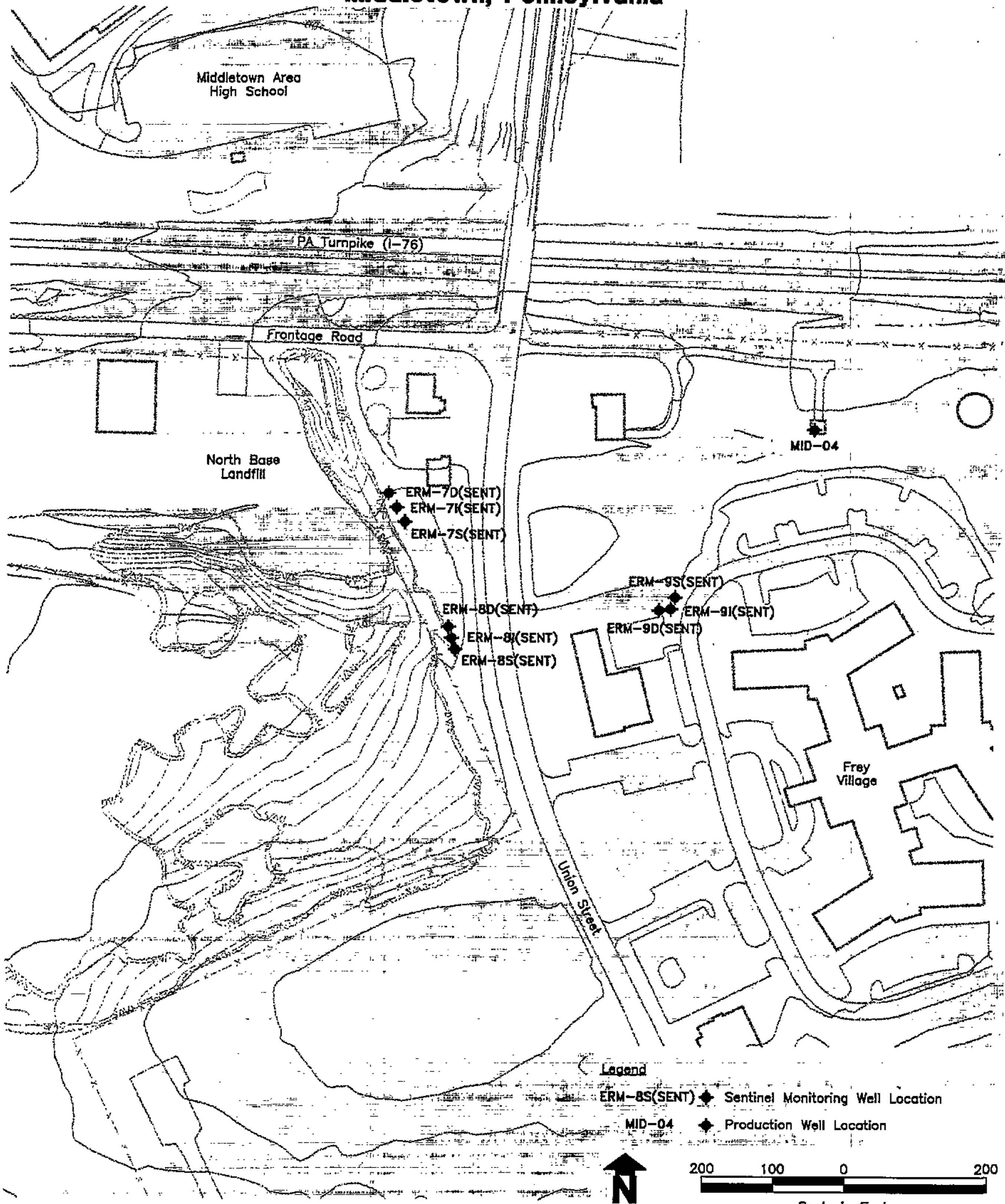
PM008.07.01/05.11.96-MKB/06.14.96-MKB/I203 -1B

Figure D-9C
North Base Landfill Area
Sentinel Well Locations
Middletown Airfield NPL Site
Middletown, Pennsylvania



Monitoring well borings were sampled from the ground surface to bedrock according to the following:

- at 2.5 foot intervals from the ground surface to 10 feet below grade, and
- at 5 foot intervals from 10 feet below grade to total depth of the boring.

Samples from the overburden were collected using split spoon samplers. Cuttings were described while drilling the bedrock with air rotary. All overburden sampling was accomplished using a 140-pound hammer to advance a split spoon (ASTM Method D1586-67). The number of blows required to advance the sampler through each 6-inch interval over a distance of 2 feet was recorded. Auger flights were advanced only to the top of the interval to be sampled; the split spoon was then driven ahead of the augers. Individual, decontaminated split spoons were used to collect each sample.

Soil samples were visually described in the field. Descriptions included:

- USCS classification,
- consistency or density,
- moisture content,
- color (munsell soil color charts),
- bedding characteristics, fractures, or other descriptive features, and
- depositional type if known (till, alluvium, etc.).

Logging of cuttings returned to the surface during bedrock drilling was performed at least every 5 feet of borehole drilled. Bedrock cuttings were described based upon A.G.I. Data Sheet 32.1 for naming conventions. Color, degree of weathering, reaction to acid, and other features were also described.

Formation samples from eight of the ten overburden monitoring well borings in the Industrial Area along the pipeline and at the lagoons were screened on-site by ERM-FAST® for the same select VOCs and SVOCs as the samples from the soil borings. The samples were analyzed with 24-hour turnaround. Because wells ERM-34S and -35S were installed after the on-site laboratory had demobilized, samples from those boreholes were screened with an OVA. The samples were designated with the prefix "IAP", "IAL", or "IAB" for the pipeline, lagoon, or building areas, respectively, followed by the monitoring well number and the sample depth. For example, a sample collected at a depth of 0.5 to 2.0 feet below grade from monitoring well boring ERM-1S in the pipeline area was designated IAP-ERM1S(0.5-2.0).

Three samples from eight of the ten Main Building Area and Lagoon monitoring well borings and two samples each from well borings ERM-34S and -35S were selected for additional laboratory analyses based on the selection criteria described in Section D.7.2. The samples from the eight well borings were analyzed on-site by ERM-FAST® for the TCL VOCs plus TICs and by the off-site laboratory for TCL SVOCs plus TICs, TCL Pesticides, TAL total metals, cyanide (total and amenable), TOC, and CEC. Samples collected from well borings ERM-34S and -35S were analyzed for all the same parameters, the only difference was that the VOC analysis was performed by the off-site laboratory. The samples from the three overburden monitoring well borings (IAB-ERM4S, -ERM5S, and -ERM27S) in the Main Buildings Area and from the overburden well boring (ERM-1S) in the mid-Lagoon Area were also analyzed for TCL PCBs.

One surface scrape sample was collected from one of the three overburden monitoring well locations in the Main Buildings Area (IAP-ERM2S [SSC]) and from the mid-Lagoon location (ERM-IS [SSC]). The surface scrape samples were analyzed by the off-site laboratory for the same parameters as the split spoon samples, including TCL PCBs. The surface scrape samples were not analyzed for TCL VOCs.

Generally, two samples per shallow monitoring well boring were retained for geotechnical analysis. The analyses consisted of grain size distribution, Atterberg limits, and moisture content. One of the samples for geotechnical analysis was collected from the portion of the aquifer which was screened in the monitoring well, and one sample was collected from the unsaturated zone.

D.11.2 *Intermediate and Deep Bedrock Wells*

Bedrock monitoring wells were drilled using dual rotary drilling techniques. Dual rotary drilling allows a lower rotary drive unit to spin and advance steel casing (up to 24 inches in diameter) through overburden and bedrock. A carbide-studded shoe, welded to the bottom of the casing, enables the casing to cut its way through the material. A top drive rotary head simultaneously handles a drill string equipped with a conventional down-hole hammer rock bit (or tricone roller bit in one case) to drill inside or ahead through the casing. The lower rotary drive unit operates independently from the top drive rotary head and in fact rotates in the opposite direction. Once a given casing has been set to the desired depth, a smaller diameter casing and air hammer with a drill bit can be installed and drilling continues to the total depth of the hole. If the outside casing is halted, the top drive can advance the hammer and bit drilling in a conventional air hammer open-hole manner.

The advantage of the dual rotary method is that it cases off the borehole with temporary casing as the hole is drilled; thereby, minimizing cross contamination and maintaining borehole stability. Casings were removed prior to or during well construction. There was a single exception to the above methodology where the well borehole to ERM-20I was drilled using the same methodology as that of the shallow monitoring well boreholes (HSA drilling to top of bedrock followed by conventional air rotary drilling with a tricone roller bit).

Logging of cuttings returned to the surface during bedrock drilling was performed at least every 5 feet of borehole drilled. Bedrock cuttings were described based upon naming conventions from A.G.I. Data Sheet 32.1. Color, degree of weathering, reaction to acid, and other features were also described.

Forty intermediate and deep bedrock wells were installed during this investigation. Their locations, depths, diameters, and screened intervals are presented in Table D-8. The intermediate and deep monitoring wells in the Industrial Area pipeline and main building areas were not installed until a majority of the shallow monitoring wells in those areas were sampled and analyzed for TCL VOCs, as described in Section D.13.2. Those analytical results were used to determine the best locations for the intermediate and deep monitoring wells.

Borehole geophysical logging was conducted in the intermediate and deep capture zone and the deep sentinel well boreholes prior to monitoring well installation, as described in Section D.12. In addition, borehole camera surveys were performed in these wells, plus the intermediate and shallow sentinel well boreholes. The camera survey was used principally to select intervals to be straddle-packer tested, and these packer tests were conducted to provide confirmation that the intervals to be screened were productive. Based on the borehole testing described above, ERM selected the screened intervals and informed USACE of these decisions. Geophysical logs are presented in Appendix B.

D.11.3 *Monitoring Well Installation Procedures*

Once the desired depth was reached and the required downhole testing had been completed, monitoring wells were constructed of the appropriate diameter and material. All well materials were steam cleaned prior to installation. All screen and riser material were threaded, flush jointed, Schedule 40 polyvinyl chloride (PVC), or Schedule 5 or 10 stainless steel (SS) (Schedule 40 SS at the flush threaded joints). The screens were continuous wrap PVC or SS.

The annular space around the well screen was backfilled with clean, silica sand. This filter pack was tremied into place to avoid bridging and extended approximately 1 foot below (to total depth of the borehole) and 3 feet above the well screen. A minimum 2 foot thick bentonite seal was placed above the filter pack. The seal was composed of commercially manufactured sodium bentonite pellets or bentonite slurry. The seal was allowed to hydrate (or set up in the case of the slurry) a minimum of 4 hours before grouting began. Cement grout was placed above the bentonite seal and consisted of a mixture of Portland cement and water in a proportion of not more than 7 gallons of approved water to one 94 pound bag of cement. Additionally, 3 percent by weight of sodium bentonite powder was added to the grout mixture. Grout extended from the top of the bentonite seal to ground surface. Well construction diagrams were completed for each well installed. These accompany the lithologic logs for each well and are found in Appendix A.

The well riser was surrounded by a protective steel casing or flush vault. The protective vaults had attached to them a permanent, corrosion resistant tag that identifies the well number, depth, date of installation, the U.S. Army Corps of Engineers, Omaha District, and the adjusted top of casing elevation. All wells were secured with non-rusting, keyed alike locks.

D.11.4 *Well Development*

No sooner than 48 hours after grouting, newly installed monitoring wells were developed. Development was accomplished by mechanical surging and bailing. This continued for a minimum of 2 hours. After the initial 2 hours, the well was continuously pumped using a submersible pump. In a few cases where the well yield was very low, the wells were bailed to completion. Concurrent with the development activities, a plumbness and alignment survey was performed on each monitoring well. This test entailed the lowering of a 10 foot long section of pipe that was approximately 0.5 inches less (outer diameter) than the well riser (inner diameter). This pipe was passed freely for the entire depth of the monitoring wells. In this field investigation the pipe used to run the plumbness and alignment survey was a 10 foot long stainless steel bailer constructed for this effort and utilized in the development of the monitoring wells.

During development, field measurements of temperature, pH, specific conductivity, and turbidity were monitored while purging of the wells at a rate of approximately one reading per well volume. Pumping continued until these parameters had stabilized and the water was clear and free of fines. A 1 liter sample of the last water withdrawn was retained in a clear glass jar and photographed. This photograph was submitted as part of the well installation diagram to the USACE. A Well Development Form was completed for each monitoring well and can be found in Appendix H.

Handling and disposition of well development water is discussed in Section D.18.2.

D.11.5 Well Abandonment or Repair

Several monitoring wells were damaged during installation. All such wells were abandoned and replaced with new wells. If the damage was discovered prior to the well casing being sealed and grouted, the well borehole was drilled out and the monitoring well was reinstalled with new materials. If the well was discovered to be faulty after the annulus had been sealed and grouted, the inside of the well casing was grouted from the total depth of screen to the surface with Portland cement and ~20% bentonite (by weight). The surface riser was cut off and any vault was removed. This procedure was consistent with those detailed in PADER Well Abandonment Procedures (Draft May 1994 PADER, Bureau of Topographic and Geologic Survey). All abandoned replacement wells were documented with appropriate well diagrams which accompany the lithologic logs for each well.

During the plumbness and alignment check on ERM-32D, some sand pack was noted in the bottom of the well screen. The presence of this sand indicates a break in the screen section. The well was examined with a down hole video camera and the breakage was observed at the very bottom of the screen section. As such, a custom built plug was installed at the bottom of the well to prevent further sand pack from entering the well. This plug was designed and built to be transmissive to water flow. The installation of this plug was documented on a well construction diagram which accompanies the lithologic log for the well.

D.12 BOREHOLE GEOPHYSICS AND DOWNHOLE VIDEO SURVEY

Borehole geophysical surveys were conducted in the following well borings prior to well installation:

- 3 deep bedrock sentinel wells ERM-7D(SENT), ERM-8D(SENT), ERM-9D(SENT)
- 6 intermediate and 6 deep bedrock HIA capture zone monitoring wells (ERM-21I/D, ERM-22I/D, ERM-23I/D, ERM-24I/D, ERM-25I/D, ERM-26I/D; and
- 3 HIA production wells where depth specific sampling was performed, HIA-2, HIA-9, and HIA-13.

Borehole video camera surveys were conducted in the following borings:

- three shallow bedrock, three intermediate bedrock, and three deep bedrock sentinel wells (ERM-7S,I,D(SENT), ERM-8S,I,D(SENT), ERM-9S,I,D(SENT));
- six intermediate and six deep HIA capture zone monitoring wells; and
- the three HIA production wells where depth specific sampling was performed.

The downhole video surveys of monitoring well boreholes were performed to select appropriate zones for straddle packer testing.

D.12.1 Techniques

ERM's subcontractor *welenco, inc.*, performed the geophysical logging and downhole color video surveys of the three HIA production wells during the depth specific sampling. Geophysical logging was performed on the remainder of the above listed well boreholes by ERM. The downhole video logging of the shallow, intermediate, and deep sentinel well boreholes, and the intermediate and deep capture zone well boreholes were performed by Hydro Group, Inc. The borehole geophysical logging techniques used in the monitoring well boreholes prior to well installation are summarized in Table D-10.

All downhole tools and cables were decontaminated between boreholes. Standard logging tool calibration checks were performed and

Table D-10
Borehole Geophysical Logging Techniques
Middletown Airfield NPL Site

Geophysical Tool	Parameters Measured	Where Used
3 arm caliper	borehole diameter, irregularities	All logged wells
acoustic	borehole compensated P-wave velocity formation porosity	All logged wells
temperature	fluid temperature gradient fluid temperature differential	All logged wells All logged wells
natural gamma ray	natural gamma emission of formation	All logged wells
fluid resistivity	fluid resistivity 64" normal resistivity 16" normal resistivity lateral resistivity	All logged wells All logged wells All logged wells All logged wells
electric log	spontaneous potential single point resistance	All logged wells All logged wells
spinner flow meter	velocity of water entering borehole	HIA-2, HIA-9 and HIA-13

documented. Copies of these logs, on a scale of 5 inches per 100 feet, are provided in Appendix B. Digital logs on diskettes in DOS ASCII format were provided to the USACE.

The borehole video survey was conducted before the geophysical logging in order to minimize disturbance of the water column which may affect quality of the picture. It became clear from the outset of the program that post drilling turbidity of water within the boreholes was high enough to prevent good video documentation. A pre-video cleaning of the borehole was needed. This procedure varied, but entailed the purging of the borehole water by means of extra post drilling blowing out of the borehole with the drilling rig, dual wall air-lifting, or conventional pumping. The video survey was monitored on a real-time basis as the camera was lowered down the borehole and simultaneously recorded on a VHS format video tape. Special attention was given to identification of potential water-producing zones indicated by the presence of lithologic changes and fractures (open and sealed). A footage meter recorded depth from the starting point and continually projected the depth on the video screen. A copy of the video tapes, labeled with location, well number, total depth, and date of survey, was provided to the USACE.

D.12.2 *Depth-Specific Sampling of HIA Wells*

Locations of the water producing zones in HIA Production Wells 2, 9, and 13 were determined through the use of geophysical and television borehole logs. Depth-specific sampling was conducted from five likely water producing zones identified from the borehole logs, under flowing and non-flowing conditions. The sampling intervals selected for the three HIA Production wells were the following:

- HIA-2 (eastern area); 103, 175, 238, 310, and 412 feet BLS,
- HIA-9 (western area); 102, 143, 201, 256, and 420 feet BLS, and
- HIA-13 (central area); 97, 138, 345, 480, and 725 feet BLS.

The locations of the HIA production wells are shown on Figure D-9A. ERM's subcontractor for the Depth Specific Sampling tasks was *welenco, inc.*, of Bakersfield, CA. Hydro Group, Inc. performed the associated pump work.

The existing pumps were removed from each well, and a borehole color television survey was conducted of the casing and open borehole. Geophysical logging, using the following tools, was conducted in the following order: temperature, fluid resistivity, caliper, spinner flow meter, neutron log and natural gamma log. Depth-specific sampling was then conducted from five likely water producing zones identified from the geophysical logs.

Upon completion of sampling under static conditions, a test pump and access pipe were installed in the well. The pump was activated and allowed to purge the well. Geophysical logging, including spinner flow meter, temperature, and fluid resistivity was conducted while the pump was running. Depth-specific sampling was then conducted while the well was being pumped from the same five zones previously sampled.

D.13 GROUND WATER SAMPLING

Ground water sampling and analysis was conducted at 67 newly installed ERM monitoring wells, 45 of the 50 existing on-site monitoring wells, 15 production wells (including the 14 HIA wells and MID-04), and eight residential wells. Specialized depth specific ground water sampling was also conducted at three HIA production wells.

D.13.1 Water Level Measurements

Two complete rounds of water level measurements was conducted prior to the ground water sampling event. A measurement of water level and non-aqueous phase liquid (NAPL) thicknesses for all new and existing wells was taken prior to sampling of the monitoring wells. The water level, NAPL thickness if any, time of measurement, well depth, weather conditions at the time of measurement, and date were recorded. Measurements from all wells were completed within the smallest time frame possible to reduce external variables. A maximum 24-hour interval was allowed for completion of the water level measurements. This data is presented on Table D-11.

D.13.2 Monitoring Well Sampling

All newly installed monitoring wells were developed according to the procedures described in Section D.11.4 and allowed to stabilize for a minimum of 2 weeks prior to ground water sampling. Five new shallow monitoring wells in the Industrial Area (two in the pipeline area and three in the main building areas) were sampled 2 weeks after development, and the samples were analyzed by the off-site laboratory for TCL VOCs plus TICs with 14 day turnaround to provide data to determine the appropriate locations for the proposed intermediate and deep monitoring wells.

Ground water samples were also split from monitoring wells ERM-13I, -14I, -16I, and -17I located on the Fruehauf Corporation property on 5 January 1995 as part of a due diligence study. The samples were analyzed by the off-site laboratory for TCL VOCs plus TICs with standard turnaround time. Wells ERM-11I, -12I, -12S, GF-302 and RFW-1, located on the south side of the North Base Landfill, were sampled in March 1995 prior to the site-wide ground water sampling in May 1995 to determine the potential need to install additional shallow, intermediate, or deep monitoring wells in the area. The ground water samples were analyzed

Table D-11
New and Existing Monitoring Well Water Level Summary
Middletown Airfield NPL site

Location of Well	Well I.D.	Elevation TOC (MSL)	26,27 April 1995 Depth to Water (feet BTOC)	Potentiometric Surface Elevation	8,9 May 1995 Depth to Water (feet BTOC)	Potentiometric Surface Elevation	Meas. T.D. of Well	OB/BR Well
Main	ERM-1S	295.22	6.72	288.50	7.16	288.06	13.46	OB
Building	ERM-1I	294.96	6.28	288.68	7.26	287.70	98.65	BR
/Lagoon	ERM-2S	298.29	7.47	290.82	7.55	290.74	16.86	OB
Area Wells	ERM-3S	300.96	14.99	285.97	15.17	285.79	16.58	OB
	ERM-4S	299.57	13.52	286.05	13.71	285.86	19.60	OB
	ERM-5S	297.26	10.99	286.27	11.20	286.06	19.35	OB
	ERM-6S	302.36	16.28	286.08	16.48	285.88	23.50	OB
	ERM-10I	301.00	14.69	286.31	14.97	286.03	99.85	BR
	ERM-27S	300.93	14.65	286.28	14.89	286.04	22.76	OB
	ERM-28S	298.55	8.35	290.20	8.53	290.02	21.45	BR
	ERM-32I	297.31	11.54	285.77	11.84	285.47	100.10	BR
	ERM-32D	297.25	20.40	276.85	21.51	275.74	300.00	BR
	ERM-33I	297.09	11.40	285.69	10.54	286.55	131.89	BR
	ERM-34S	297.07	8.74	288.33	9.23	287.84	17.50	OB
	ERM-34I	297.06	8.42	288.64	9.00	288.06	99.90	BR
	ERM-35S	299.33	11.54	287.79	11.84	287.49	19.37	OB
	ERM-35I	299.04	11.59	287.45	11.56	287.48	99.78	BR
	GF-209	300.93	2.45	298.48	11.32	289.61	12.81	OB
	GF-309	300.05	9.68	290.37	10.19	289.86	83.25	BR
	GF-210	328.59	28.53	300.06	29.72	298.87	38.58	OB
	GF-310	327.33	27.20	300.13	28.35	298.98	102.57	BR
	GF-211	332.09	dry		dry		28.40	OB
	GF-311	332.16	29.46	302.70	30.39	301.77	97.91	BR
	GF-212	300.72	12.29	288.43	12.00	288.72	37.47	OB
	GF-312	300.87	13.61	287.26	12.53	288.34	99.91	BR
	GF-214	312.67	dry		dry		19.20	OB

Table D-11

New and Existing Monitoring Well Water Level Summary

Middletown Airfield NPL site

Location of Well	Well I.D.	Elevation TOC (MSL)	26,27 April 1995 Depth to Water (feet BTOC)	Potentiometric Surface Elevation	8,9 May 1995 Depth to Water (feet BTOC)	Potentiometric Surface Elevation	Meas. T.D. of Well	OB/ BR Well
	GF-314	311.98	25.52	286.46	25.76	286.22	97.58	BR
	GF-217	299.86	11.24	288.62	11.54	288.32	21.39	OB
	GF-317	299.78	11.06	288.72	11.38	288.40	88.51	BR
	GF-218	299.44	13.32	286.12	13.53	285.91	22.41	OB
	GF-318	302.46	14.43	288.03	15.47	286.99	90.60	BR
	GF-219	302.43	15.03	287.40	15.24	287.19	24.44	OB
	GF-220	305.85	16.49	289.36	16.77	289.08	26.84	OB
	GF-221	317.90	19.57	298.33	19.97	297.93	32.50	OB
	GF-222	298.43	9.63	288.80	9.89	288.54	19.25	OB
	GF-223	301.64	13.72	287.92	14.10	287.54	18.89	OB
	GF-225		paved over		paved over			OB
	GF-226	334.50	31.60	302.90	32.66	301.84	50.13	BR
	GF-227	299.14	9.13	290.01	9.49	289.65	19.34	OB
	RFW-2	308.29	can't loc.			308.29	29.20	OB
	RFW-3	308.49	15.81	292.68	15.03	293.46	23.84	OB
	RFW-4	307.73	14.70	293.03	14.24	293.49	26.95	OB
	RFW-5	305.93	paved over		paved over	#VALUE!	29.80	OB
Capture	ERM-21S	303.44	18.57	284.87	18.83	284.61	34.83	BR
Zone	ERM-21I	303.08	18.17	284.91	18.34	284.74	199.76	BR
Wells	ERM-21D	303.23	24.56	278.67	25.27	277.96	599.17	BR
	ERM-22S	308.37	23.42	284.95	23.73	284.64	43.07	BR
	ERM-22I	309.21	24.75	284.46	24.89	284.32	199.47	BR
	ERM-22D	308.41	23.69	284.72	23.29	285.12	599.13	BR
	ERM-23S	301.47	15.04	286.43	15.30	286.17	24.44	OB
	ERM-23I	301.45	26.06	275.39	26.54	274.91	196.58	BR

Table D-11
New and Existing Monitoring Well Water Level Summary
Middletown Airfield NPL site

Location of Well	Well I.D.	Elevation TOC (MSL)	26,27 April 1995 Depth to Water (feet BTOC)	Potentiometric Surface Elevation	8,9 May 1995 Depth to Water (feet BTOC)	Potentiometric Surface Elevation	Meas. T.D. of Well	OB/ BR Well
	ERM-23D	301.70	30.35	271.35	37.19	264.51	593.59	BR
	ERM-24S	299.97	13.58	286.39	13.88	286.09	24.39	OB
	ERM-24I	300.05	19.64	280.41	22.59	277.46	199.07	BR
	ERM-24D	300.12	25.12	275.00	37.93	262.19	598.85	BR
	ERM-25S	330.04	32.45	297.59	32.87	297.17	45.45	BR
	ERM-25I	330.20	47.46	282.74	39.86	290.34	189.91	BR
	ERM-25D	330.16	36.42	293.74	42.68	287.48	599.19	BR
	ERM-26S	331.25	32.97	298.28	35.55	295.70	45.97	BR
	ERM-26I	331.28	71.79	259.49	42.11	289.17	200.06	BR
	ERM-26D	331.11	38.03	293.08	44.46	286.65	599.92	BR
Runway	ERM-18S	301.98	16.18	285.80	16.66	285.32	19.72	OB
Wells	ERM-18I	302.18	16.72	285.46	17.11	285.07	120.22	BR
	ERM-19S	299.72	12.49	287.23	12.87	286.85	18.79	OB
	ERM-20S	301.11	17.29	283.82	18.35	282.76	25.37	OB
	ERM-20I	301.04	17.42	283.62	18.32	282.72	119.80	BR
	GF-207	297.95	12.87	285.08	15.88	282.07	18.77	OB
	GF-307	298.03	13.19	284.84	13.92	284.11	90.39	BR
	GF-208	307.27	18.50	288.77	23.46	283.81	29.10	OB
	GF-308	307.42	22.54	284.88	23.58	283.84	112.54	BR
	GF-215	302.17	14.27	287.90	14.52	287.65	17.78	OB
	GF-315	305.39	15.14	290.25	15.57	289.82	93.72	BR
	WRT-01	301.46	16.31	285.15	17.25	284.21	52.62	BR
	WRT-02	301.79	17.16	284.63	17.86	283.93	49.60	BR
	WRT-03	302.62	18.02	284.60	18.72	283.90	50.65	BR

Table D-11

New and Existing Monitoring Well Water Level Summary

Middletown Airfield NPL site

Location of Well	Well I.D.	Elevation TOC (MSL)	26,27 April 1995 Depth to Water (feet BTOC)	Potentiometric Surface Elevation	8,9 May 1995 Depth to Water (feet BTOC)	Potentiometric Surface Elevation	Meas. T.D. of Well	OB/ BR Well
	WRT-04	301.48	16.88	284.60	17.65	283.83	53.11	BR
	WRT-05	303.36	17.38	285.98	17.75	285.61	50.84	BR
	WRT-06	301.69	15.10	286.59	can't loc.		50.25	BR
	WRT-07	302.58	18.88	283.70	19.63	282.95	49.48	BR
	RFW-06	300.83	can't locate		can't loc.		115.53	BR
	RFW-07	299.47	14.96	284.51	can't loc.		23.98	OB
North Base Landfill Wells	ERM-11S	368.73	10.15	358.58	9.88	358.85	24.69	BR
	ERM-11I	370.34	10.34	360.00	10.82	359.52	99.79	BR
	ERM-12S	379.40	4.27	375.13	4.62	374.78	20.61	BR
	ERM-12I	379.17	14.44	364.73	15.80	363.37	100.12	BR
	ERM-13S	383.12	12.98	370.14	12.89	370.23	21.62	BR
	ERM-13I	382.98	13.00	369.98	13.47	369.51	101.25	BR
	ERM-14S	384.08	14.88	369.20	13.39	370.69	33.00	BR
	ERM-14I	384.82	14.26	370.56	14.70	370.12	107.70	BR
	ERM-15I	399.15	13.30	385.85	13.45	385.70	99.70	BR
	ERM-16S	377.33	11.81	365.52	11.86	365.47	43.97	BR
	ERM-16I	377.24	14.77	362.47	15.50	361.74	101.14	BR
	ERM-17S	377.22	24.66	352.56	24.56	352.66	44.59	BR
	ERM-17I	377.31	21.21	356.10	21.60	355.71	101.17	BR
	ERM-29S	376.53	31.72	344.81	31.93	344.60	45.16	BR
	ERM-29I	376.61	21.75	354.86	22.01	354.60	99.78	BR
	ERM-30S	366.73	8.85	357.88	8.72	358.01	19.53	BR
	ERM-30I	366.84	7.94	358.90	8.17	358.67	100.10	BR
	ERM-31I	377.99	15.78	362.21	16.20	361.79	200.32	BR
	GF-301	403.61	18.19	385.42	18.32	385.29	89.48	BR

Table D-11
New and Existing Monitoring Well Water Level Summary
Middletown Airfield NPL site

Location of Well	Well I.D.	Elevation TOC (MSL)	26,27 April 1995 Depth to Water (feet BTOC)	Potentiometric Surface Elevation	8,9 May 1995 Depth to Water (feet BTOC)	Potentiometric Surface Elevation	Meas. T.D. of Well	OB/ BR Well
	GF-302	378.00	15.61	362.39	15.93	362.07	89.51	BR
	GF-303	398.19	21.79	376.40	28.47	369.72	89.31	BR
	RFW-1	379.02	4.61	374.41	5.26	373.76	103.23	BR
Sentinel	ERM-7S(SENT)	408.03	28.48	379.55	29.03	379.00	146.72	BR
Wells	ERM-7I(SENT)	408.46	44.67	363.79	44.22	364.24	333.71	BR
	ERM-7D(SENT)	409.62	155.49	254.13	157.00	252.62	643.35	BR
	ERM-8S(SENT)	409.69	30.44	379.25	30.98	378.71	124.57	BR
	ERM-8I(SENT)	409.24	56.09	353.15	55.61	353.63	343.80	BR
	ERM-8D(SENT)	408.61	157.97	250.64	159.31	249.30	643.95	BR
	ERM-9S(SENT)	419.99	39.08	380.91	39.61	380.38	144.29	BR
	ERM-9I(SENT)	420.51	64.88	355.63	64.83	355.68	348.22	BR
	ERM-9D(SENT)	421.16	171.96	249.20	172.88	248.28	670.91	BR
Fire	GF-203	306.90	20.85	286.05	22.05	284.85	26.00	OB
Training	GF-204	307.45	20.72	286.73	22.21	285.24	30.35	OB
Pit	GF-205	312.49	27.54	284.95	28.61	283.88	33.74	OB
Wells	GF-305	309.05	23.83	285.22	24.96	284.09	102.09	BR
Production	HIA-1	324.32					629	BR
Wells	HIA-2	325.92					450	BR
	HIA-3	320.21					450	BR
	HIA-4	325.05					450	BR
	HIA-5	320.65					450	BR
	HIA-6	296.15					500	BR
	HIA-7	-	Under concrete foundation					BR

Table D-11

New and Existing Monitoring Well Water Level Summary

Middletown Airfield NPL site

Location of Well	Well I.D.	Elevation TOC (MSL)	26,27 April 1995 Depth to Water (feet BTOC)	Potentiometric Surface Elevation	8,9 May 1995 Depth to Water (feet BTOC)	Potentiometric Surface Elevation	Meas. T.D. of Well	OB/ BR Well
	HIA-8	-	Under concrete apron					BR
	HIA-9	309.32					450	BR
	HIA-10	307.09	18.19		18.18		450	BR
	HIA-11	307.07					603	BR
	HIA-12	301.00					603	BR
	HIA-13	304.99					800	BR
	HIA-14	-					800	BR
	HIA-16	-					350	BR
	HIA-17	385.76					700	BR
	HIA-18	385.13					350	BR
	MID-04	414.05					815	BR

GF = Gannett Fleming wells installed during Remedial Investigation
RFW = R.F. Weston Wells
WRT = R.E Wright Wells
MSL = Mean Sea Level
BR = Bedrock
OB = Overburden
BTOC = Below Top of Casing

by the off-site laboratory for TCL VOCs plus TICs with 14 day turnaround. Subsequently, all monitoring wells were sampled during a comprehensive ground water sampling event. Sampling forms for each well are provided in Appendix I.

The monitoring wells were purged and sampled proceeding from area to area. There was also an effort to sample from the suspected least to most contaminated wells within the given area to minimize potential cross-contamination.

Depth to water and total depth of each well was measured with an electronic water level probe prior to purging (Table D-11). The presence of NAPL at the top and bottom of the water column was also determined prior to purging using an oil-water interface probe. There was no NAPL measured in the monitoring wells.

A submersible or centrifugal pump was used for well evacuation. When the centrifugal pump was used, a disposable purge line and check valve located at the hose intake was placed into the well. Proper pump or intake placement ensured complete and proper evacuation of purge water. The depth of pump placement depended on the well yields. Small diameter pumps typically have low flow rates (1-7 gpm), necessitating initial placement of the pump intake at various locations throughout the water column in high yielding wells. The pump was initially placed at the bottom of the well then raised upward through the water column of the well as purging proceeded to ensure that all of the stagnant water in the well was removed. Pump placement remained near the bottom of the well for low yielding wells. Pumps were placed into and removed from the wells slowly and gently to minimize turbidity levels. Upon removal of the required purge volume, the pump system was removed from the well. Wells that were inaccessible with the pump system, or wells that have very low yields, were hand bailed using dedicated PVC or decontaminated stainless steel bottom-loading bailers.

The temperature, pH, specific conductance, and turbidity of the purge water were measured and recorded during the purging process and are presented on Table D-12. Field parameters were measured at the start of purging and twice per casing volume removed. All measurement probes were rinsed with distilled water between samples. The meters were field calibrated according to the procedures described in the QAPP. The well was purged beyond three casing volumes until the field parameters had stabilized (0.2 pH units or a 10 percent change for the other parameters between four consecutive readings). The total purge volume was

Table D-12
Well Sampling Records
Middletown Airfield NPL Site

Well I.D.	Depth to water (ft. bmp)	Total Well Depth (ft. bmp)	Well Type and Diameter	Water Volume in Well (gal.)	Approx. Purge Rate (GPM)	Duration of Purging (min.)	Volume Purged (gal)	Purge Method	Method of Sample Collection	Date of Sample Collection	Time of Sample Collection	Sample Temp (C)	Sample pH	Sample Conductivity (umhos/cm)	Sample Turbidity (NTU)
Main Bldg./ Lagoon Area Wells															
ERM-1S	7.19	13.46	2" PVC	1.02	2	6	12	C	B	5/17/95	1030	14	6.4	500	94.6
ERM-1I	6.77	98.65	2" PVC	15.00	5	20	46	C	B	5/17/95	1020	13	6.9	500	8.1
ERM-2S	7.51	16.86	2" PVC	1.53	0.5	10	5	B	B	5/15/95	1500	15	6.5	700	200+
ERM-3S*	dry	-	2" PVC	-	-	-	-		no sample	-	-	-	-	-	-
ERM-4S	13.46	19.60	2" PVC	1.00	0.5	23	3	B	B	5/15/95	1122	15	7.6	500	200+
ERM-5S	11.73	19.35	2" PVC	1.25	0.5	10	4	B	B	5/12/95	1330	16	6.5	600	200+
ERM-6S	16.89	23.50	2" PVC	1.10	1.5	9	15	C	B	5/12/95	1127	15	6.6	460	200+
ERM-10I	15.37	99.85	2" PVC	13.80	1	49	43	C	B	5/18/95	1402	16	6	500	2
ERM-27S	15.18	22.76	2" PVC	1.30	0.5	15	4.5	B	B	5/16/95	1720	15	6.3	460	200+
ERM-28S	8.74	21.45	2" PVC	2.10	0.5	19	7	B	B	5/17/95	1634	13.5	6.1	700	200+
ERM-32I	12.49	100.10	2" PVC	14.50	2	25	45	C	B	5/24/95	1124	20.5	6.9	500	13.9
ERM-32D	16.12	295.90	4"PVC	181.90	-	-	640	S	B	9/5/95	1610	18	6.8	600	17
ERM-33I	10.09	131.89	2" PVC	20.00	2	36	68	S	B	5/24/95	1032	20	7.7	370	29.5
ERM-34S	9.49	17.50	2" PVC	1.30	0.5	11	5	B	B	5/23/95	1209	15	6.4	430	200+
ERM-34I	9.22	99.90	2" PVC	15.00	5.5	13	65	C	B	5/23/95	1227	17	7	480	2.7
ERM-35S	12.19	19.37	2" PVC	1.20	0.5	12	5	B	B	5/24/95	930	14	6.1	415	200+
ERM-35I	11.87	99.78	2" PVC	14.50	2	23	46	C	B	5/24/95	922	14	7.3	415	200+
GF-209	11.25	12.81	2" PVC	0.25	-	-	.25 (dry)	B	BSS	5/18/95	1055	17	6.3	490	200+
GF-309	10.22	83.25	6" SS	108.00	10	37	370	C	BSS	5/18/95	1105	15	6	500	14.5
GF-210	31.31	38.58	2" PVC	1.20	0.5	14	4	B	BSS	5/25/95	1222	17.5	5.4	500	200+
GF-310	30.69	102.57	6" SS	105.00	7	26	330	S	BSS	5/25/95	1252	17.5	6.9	230	33.7
GF-211*	dry	28.40	2" PVC	-	-	-	-	-	no sample	-	-	-	-	-	-
GF-311	29.86	97.91	6" SS	100.00	5	60	300	S	BSS	5/16/95	1615	20	7.5	75	95.6
GF-212	12.53	37.47	4" PVC	16.30	1.5	33	49	C	BSS	5/22/95	1224	17	6.8	440	50
GF-312	13.00	99.91	6" SS	128.00	8	26	208	S	BSS	5/23/95	1745	16	7.2	600	96.5
GF-214*	dry	19.20	2" PVC	-	-	-	-	-	no sample	-	-	-	-	-	-
GF-314	26.58	97.58	6" SS	103.00	10	22	310	S	BSS	5/25/95	1040	18	7.3	700	196
GF-217	12.20	21.39	2" PVC	1.50	0.3	15	5	B	BSS	5/26/95	1255	17	6.4	460	200+
GF-317	11.76	88.51	6" SS	113.00	9.5	38	350	S	BSS	5/26/95	1308	18	8	190	62
GF-218	12.90	22.41	2" PVC	1.60	0.5	19	5+	B	BSS	5/22/95	1437	15	6.3	460	200+
GF-318	15.85	90.60	6" SS	110.00	3.75	88	330	C	BSS	5/22/95	1505	17	7.7	180	66
GF-219	15.57	24.44	2" PVC	1.40	0.5	20	5	B	BSS	5/18/95	1805	15	5.9	800	200+
GF-220	16.99	26.84	2" PVC	1.60	0.25	19	5+	B	BSS	5/18/95	1601	15	5.4	500	200+
GF-221	19.65	32.50	2" PVC	2.10	0.5	17	6.5	B	BSS	5/18/95	1811	15	6.3	325	200+
GF-222	10.47	19.25	4" PVC	6.00	2	3	6 (dry)	C	BSS	5/23/95	1003	18	6	490	200
GF-223	14.79	18.89	2" PVC	0.66	0.25	10	2.5	B	BSS	6/2/95	918	16	6.6	495	200+
GF-225*	dry	-	4" PVC	-	-	-	-	-	no sample	-	-	-	-	-	-

Table D-12
Well Sampling Records
Middletown Airfield NPL Site

Well I.D.	Depth to water (ft. bmp)	Total Well Depth (ft. bmp)	Well Type and Diameter	Water Volume in Well (gal.)	Approx. Purge Rate (GPM)	Duration of Purging (min.)	Volume Purged (gal)	Purge Method	Method of Sample Collection	Date of Sample Collection	Time of Sample Collection	Sample Temp (C)	Sample pH	Sample Conductivity (umhos/cm)	Sample Turbidity (NTU)
GF-226	33.48	50.13	2" PVC	2.80	0.5	35	8.5	B	BSS	5/24/95	1515	19	6	395	139.6
GF-227	9.95	19.34	2" PVC	1.50	0.25	19	5	B	BSS	5/31/95	1648	15	6.8	750	200+
RFW-2	12.59	29.20	4" SS	11.00	0.5	27	13 (dry)	B	B	5/26/95	1024	15	6.6	350	200+
RFW-3	16.79	23.84	4" SS	4.60	1	12	15	C	B	5/23/95	1109	19	6.7	500	165
RFW-4	14.81	26.95	4" SS	7.90	1	20	24	C	B	5/22/95	1719	15	6.8	700	200+
RFW-5*	-	29.80	4" SS	-	-	-	-	-	no sample	-	-	-	-	-	-
Capture Zone Wells															
ERM-21S	19.08	34.83	2"PVC	2.6	2	10	26	C	B	5/11/95	924	14	6.8	800	112
ERM-21I	18.62	199.76	4"SS	118	3	120	360+	C	B	5/11/95	1118	14.5	7.6	335	2.8
ERM-21D	25.60	599.17	4"SS	374	8.3	135	1137	S	B	5/11/95	1110	15	7.6	500	9.9
ERM-22S	23.75	43.07	2"PVC	3.15	4	15	64	C	B	5/9/95	1304	14	6.9	950	18.8
ERM-22I	24.98	199.47	4"SS	114	5	52	354	S	B	5/9/95	1413	15	7.5	800	1.95
ERM-22D	23.32	599.13	4"SS	376	6.6	140	1128	S	B	5/9/95	1614	15	7.1	1050	5
ERM-23S	15.46	24.44	2"PVC	1.5	3	9	27	C	B	5/10/95	1618	14.5	6.3	550	200+
ERM-23I	16.19	196.58	4"SS	118	5	71	360	C	B	5/10/95	1325	15	7.1	410	1.5
ERM-23D	22.42	593.59	4"SS	373	6	195	1120	S	B	5/10/95	1733	16	7.3	500	12.3
ERM-24S	14.07	24.39	2"PVC	1.7	1	21	10	C	B	5/10/95	940	15	6.9	490	200+
ERM-24I	18.23	199.07	4"SS	118.1	1.7	135	356	S	B	5/10/95	1120	15	7.2	600	3.5
ERM-24D	38.49	598.85	4"SS	366	7	165	1098	S	B	5/10/95	1354	16.5	7	600	7
ERM-25S	32.57	45.45	2"PVC	2.1	0.25	30	7	B	B	5/12/95	935	15	7.3	700	200+
ERM-25I	35.68	189.91	4"SS	100	5	53	300	S	B	5/16/95	1515	19	7.5	360	5.5
ERM-25D	38.18	599.19	4"SS	366.5	3.2	340	1104+	S	B	5/12/95	1405	16	7.6	255	5.7
ERM-26S	34.57	45.97	2"PVC	1.9	0.5	16	6+	B	B	5/11/95	1358	19	6.5	650	28.4
ERM-26I	39.32	200.60	4"SS	104.5	7	45	319	S	B	5/11/95	1622	15	7.3	345	0.7
ERM-26D	41.28	599.92	4"SS	365	7.5	146	1428	S	B	5/11/95	1540	16	7.4	340	7.3
Runway Wells															
ERM-18S	17.23	19.72	2"PVC	0.4	0.1	18	2.5	B	B	5/31/95	1534	15	5.6	235	200
ERM-18I	17.52	120.22	2"PVC	16.43	1.5	33	50	C	B	5/31/95	1559	16	7.5	500	1
ERM-19S	13.28	18.79	2"PVC	0.9	0.2	18	3	B	B	6/1/95	1635	16	7.2	350	200+
ERM-20S	18.06	25.37	2"PVC	1.2	0.25	18	4.5	B	B	5/30/95	1434	14	9.6	900	200+
ERM-20I	18.05	119.80	2"PVC	16.6	5	20	55	S	B	5/30/95	1458	15	7.3	700	169.1
GF-207	13.32	18.77	2"PVC	0.9	0.25	12	3	B	BSS	5/31/95	1223	18	6.7	1200	33.8
GF-307	13.65	90.39	6" SS	112.8	10	51	400	C	BSS	5/31/95	1236	19	6.2	700	200+
GF-208	23.13	29.10	2"PVC	1	0.2	19	3	B	BSS	5/30/95	1158	14	10.1	1200	24.9
GF-308	23.12	112.54	6" SS	131	8	45	360	C	BSS	5/30/95	1232	15	10.8	190	64
GF-215	15.67	17.78	2"PVC	0.34	0.06	20	1.2	B	BSS	6/1/95	1535	18	6.9	310	200+
GF-315	15.98	93.72	6" SS	114.3	7.5	46	345	S	BSS	6/1/95	1604	18	7.2	340	37
WRT-01	17.16	52.62	6" SS	52.1	10	18	180	S	B	5/30/95	1625	16	7.1	175	200+
WRT-02	17.65	49.60	6" SS	46.9	10	18	180	C	B	5/30/95	1652	16.5	6.9	500	191
WRT-03	18.50	50.65	6" SS	47.5	2.8	52	150	C	B	5/31/95	1111	18.5	6.7	500	26.9

Table D-12
Well Sampling Records
Middletown Airfield NPL Site

Well I.D.	Depth to water (ft. bmp)	Total Well Depth (ft. bmp)	Well Type and Diameter	Water Volume in Well (gal.)	Approx. Purge Rate (GPM)	Duration of Purging (min.)	Volume Purged (gal)	Purge Method	Method of Sample Collection	Date of Sample Collection	Time of Sample Collection	Sample Temp (C)	Sample pH	Sample Conductivity (umhos/cm)	Sample Turbidity (NTU)
WRT-04	17.44	53.11	6" SS	52	7.5	35	160	S	B	5/31/95	1040	17.5	6.7	420	152
WRT-05	18.25	50.84	6" SS	48	7.5	25	185	S	B	6/1/95	1118	17	6.5	600	37
WRT-06	17.45	50.25	6" SS	48.2			148	C	B	6/1/95	1225	15	6.2	400	200+
WRT-07	24.84	49.48	6" SS	36.2	4	27	109	S	B	6/1/95	1700	14	6.6	360	48.5
RFW-06	15.93	115.53	6" SS	146.4	7.5	30	320 (dry)	S	B	6/1/95	1312	17	7.6	350	27.2
RFW-07	15.64	23.98	4" SS	5.5	1	6	8.25	C	B	5/31/95	1134	18	7.9	900	8.96
Fire Training Pit Wells															
GF-203*	27.91	23.59	2" PVC	-	-	-	-	-	no sample	-	-	-	-	-	-
GF-204	27.09	30.35	6"	4.8	<1	9	6 (dry)	B	BSS	5/24/95	1625	17	6.4	850	150
GF-205	27.73	33.74	2"	1	<.5	21	3	B	BSS	5/24/95	1600	17	7	900	32.5
GF-305	24.38	102.09	6"	114	5	70	350	S	BSS	5/24/95	1540	18	7.4	700	48
North Base Landfill Wells															
ERM-11S	9.91	24.69	2"PVC	2.4	<.5	10	3	B	B	5/25/95	1625	16	6.7	235	158
ERM-11I	11.28	99.79	2"PVC	14	1.5	30	45	S	B	5/25/95	1552	18.5	6.8	600	2.1
ERM-12S	4.92	20.61	2"PVC	2.6	<1	13	9	C	B	5/19/95	1035	10	6.2	240	0.3
ERM-12I	16.00	100.12	2"PVC	13.7	6	3	18	S	B	5/19/95	1055	13	7.5	440	200+
ERM-13S	12.94	21.62	2"PVC	1.4	0.5	15	6	C	B	5/15/95	1310	16	6.7	490	200+
ERM-13I	13.32	101.25	2"PVC	14.3	2.5	24	45	S	B	5/15/95	1340	17	6.6	360	4.5
ERM-14S	13.25	33.00	2"PVC	3.2	1	12	7	C	B	5/15/95	1400	15	7.6	500	500
ERM-14I	40.31	107.70	2"PVC	10.9	6.6	13	45	S	B	5/15/95	1243	18	6.8	500	8.5
ERM-15I	13.12	99.70	2"PVC	14.1	1.5	29	45	C	B	5/19/95	958	13	7.6	270	3.2
ERM-16S	11.75	43.97	2"PVC	5.25	1	24	18	C	B	5/16/95	1230	19	6.5	200	53
ERM-16I	14.65	101.14	2"PVC	14	4	16	45	S	B	5/16/95	1230	19	6.5	255	5.2
ERM-17S	24.25	44.59	2"PVC	3.3	<1	15	12	B	B	5/15/95	1600	20	5.1	205	150
ERM-17I	21.53	101.17	2"PVC	12.9	3	16	42	S	B	5/15/95	1630	18	7	310	6.3
ERM-29S	31.99	45.16	2"PVC	2.1	<.5	17	6.5	B	B	5/15/95	1725	17	6.3	385	200+
ERM-29I	22.07	99.78	2"PVC	12.6	4	11	40	S	B	5/15/95	1710	17.5	6.5	430	10.3
ERM-30S	9.13	19.53	2"PVC	1.7	<.5	15	5.5	B	B	5/24/95	1305	14.5	6.3	160	200+
ERM-30I	8.30	100.10	2"PVC	15	2.5	20	50	C	B	5/24/95	1318	18	6.9	390	4.8
ERM-31I	15.32	200.32	2"PVC	30	3	17	50	S	B	5/19/95	1328	12.5	7	900	0.06
GF-301	21.08	89.48	6"	100	8	52	415	S	BSS	5/25/95	1737	18	7.1	170	66.6
GF-302	16.21	89.51	4"	48	2	76	152	S	BSS	5/16/95	1118	20	7	200	53
GF-303	29.91	89.31	6"	95.5	5	65	375	S	BSS	5/26/95	1104	15	6.8	250	200+
RFW-1	5.54	103.23	6"	142.6	5	108	500	C	B	5/19/95	1215	13	6.8	500	35.9
GF-250	7.37	19.90	2"	2.1	<.5	24	6.5	B	BSS	5/25/95	1443	14.5	6.4	310	105.6
Sentinel Wells															
ERM-7S (SENT)	29.38	146.72	4"SS	76.5	<5	105	230	S	B	5/17/95	1716	16	6.7	500	4.1
ERM-7I (SENT)	44.30	333.71	4"SS	188.7	5	90	300	S	B	5/22/95	1802	17	7.4	550	13
ERM-7D (SENT)	159.00	643.35	4"SS	315	3	320	950	S	B	5/22/95	1843	16	8.3	250	7.5

Table D-12
Well Sampling Records
Middletown Airfield NPL Site

Well I.D.	Depth to water (ft. bmp)	Total Well Depth (ft. bmp)	Well Type and Diameter	Water Volume in Well (gal.)	Approx. Purge Rate (GPM)	Duration of Purging (min.)	Volume Purged (gal)	Purge Method	Method of Sample Collection	Date of Sample Collection	Time of Sample Collection	Sample Temp (C)	Sample pH	Sample Conductivity (umhos/cm)	Sample Turbidity (NTU)
ERM-8S (SENT)	31.26	124.57	4"SS	60.7	3	138	75 (dry)	S	B	5/17/95	1450	17	7.2	480	2.1
ERM-8I (SENT)	55.53	343.80	4"SS	187.5	2.5	108	570	S	B	5/18/95	1435	18	6	600	7.7
ERM-8D (SENT)	159.50	643.95	4"SS	315	4	363	690	S	B	5/17/95	1739	11.5	7.2	280	14.2
ERM-9S (SENT)	39.92	144.29	4"SS	68	7.5	37	30 (dry)	S	B	5/18/95	1714	17	6	380	41
ERM-9I (SENT)	65.80	348.22	4"SS	184	2	210	600	S	B	5/23/95	1437	20	7.6	310	28
ERM-9D (SENT)	174.96	670.91	4"SS	323	5	195	1000	S	B	5/23/95	1506	20	7.3	350	16.5
Production Wells															
HIA-1	-	630.00	10" SS	-	180	5	900	P	DF	5/53/95	1055	15	7.1	550	7.1
HIA-2	-	450.00	10" SS	-	200	5	1000	P	DF	5/24/95	1305	15.5	7.3	480	4.38
HIA-3	-	450.00	10" SS	-	140	5	700	P	DF	5/24/95	1335	15	7.2	710	4.8
HIA-4	-	450.00	10" SS	-	140	5	700	P	DF	5/24/95	1353	15	7	780	5.21
HIA-5	-	450.00	10" SS	-	170	5	850	P	DF	5/24/95	1325	15	7.2	440	4.1
HIA-6	-	500.00	10" SS	-	550	5	2750	P	DF	5/23/95	1120	15.5	6.8	300	3.42
HIA-9	-	450.00	10" SS	-	200	5	1000	P	DF	5/24/95	1415	16	7	510	5.16
HIA-10	-	450.00	10" SS	-	9	270	1780	P	DF	6/2/95	1125	15.7	6.8	600	6.8
HIA-11	-	603.00	10" SS	-	650	5	3250	P	DF	5/24/95	1247	15	7.2	710	3.21
HIA-12	-	603.00	10" SS	-	650	5	3250	P	DF	5/24/95	1405	15	7.4	780	2.45
HIA-13	-	800.00	10" SS	-	400	5	2000	P	DF	5/24/95	1255	15.5	7.1	890	3.01
HIA-14	-	800.00	10" SS	-	380	5	1900	P	DF	5/22/95	1000	15	7.1	425	4.22
HIA-16	-	(no access)	10" SS	-	-	-	-	-	no sample	-	-	-	-	-	-
HIA-17	-	700.00	10" SS	-	9	155	1400	P	DF	6/6/95	1205	16	6.8	400	52.7
HIA-18	-	350.00	10" SS	-	9.5	110	1040	P	DF	6/6/95	1620	12.6	7.1	230	15.6
MID-04	-	450.00	10" SS	-	500	5	2500	P	DF	6/5/95	1340	20	7.3	390	1.35
Residential Wells															
RES-01	-	unknown	unknown	-	10	10	100	P	DF	6/5/95	1505	23	6.9	490	2.95
RES-02	180.00		unknown	-	10	10	100	P	DF	6/5/95	1520	26	7.3	430	6.01
RES-03	154.00		unknown	-	10	10	100	P	DF	5/23/95	1545	17	7.2	340	3.62
RES-04	180.00		unknown	-	10	10	100	P	DF	6/5/95	1105	19	7.5	280	4.25
RES-05	-	unknown	unknown	-	10	10	100	P	DF	6/5/95	1645	24	7.4	420	4.7
RES-06	-	unknown	unknown	-	10	10	100	P	DF	5/22/95	1425	16.5	7.4	800	25.11
RES-07	-	unknown	unknown	-	10	10	100	P	DF	6/5/95	1715	18	7.4	330	1.75
RES-08	140.00		unknown	-	10	9	90	P	DF	6/5/95	1129	19	7.1	120	1.35

B = PVC Bailer (dedicated)
BSS = stainless steel bailer (dedicated)
C = Centrifugal pump
S = Submersible pump
P = existing supply well pump
SS = stainless steel
DF = direct fill of sample container(s) from spigot/outlet nearest to well head.

* Unsampled wells:
ERM-3S: dry well
GF-203: obstruction in well
GF-214: dry well
GF-225: dry well
GF-211: dry well
RFW-5: well inaccessible (paved over)

measured and recorded for each well. Slow recharging wells for which three casing volumes could not be removed were pumped or bailed dry and sampled as soon as sufficient recharge had occurred.

Submersible pumps were decontaminated between each use. The pump was placed in a container of clean tap water, and 4 to 5 gallons of approved water were run through the pump. The procedure was then repeated using a container filled with distilled water. Purge and pump decontamination water was handled according to the provisions in Section D.18.2.

Ground water samples were collected using dedicated and decontaminated PVC or stainless steel bailers. Disposable braided polyester line was used to raise and lower the bailers. Samples were collected within 2 hours of well evacuation. If well yields were extremely low, the samples were collected as the well recovered and provided a sufficient volume of water for sample collection. Low yielding wells were given the entire day to recover. If necessary, samples were collected the following day.

Ground water samples were placed in laboratory-supplied sample containers with the proper preservatives already added in accordance with the specific analyses required. Samples were collected in a manner which minimized agitation of the water column and reduced the possibility of loss of volatile constituents during transfer of the sample to the sample containers. Samples for VOC analysis were collected first at each monitoring well location. The sample containers were filled slowly and completely so that no air bubbles become trapped inside the container. Ground water samples that were collected for dissolved metals analysis were field filtered prior to preservation. Water samples were submitted to the offsite laboratory for analysis for the parameters listed on Table D-13.

D.13.3 Production and Residential Well Sampling

ERM coordinated with HIA, the Middletown Water Department, and local residents to schedule the sampling of the production and residential wells. ERM obtained information about the wells, including location, condition, depth, whether or not the well was in use, estimated yield, type of pump, and well logs, as available.

Fourteen production wells were sampled, including 13 HIA wells and the Middletown Borough Well MID-04. In addition, ERM determined the

Table D-13
Site Wide Ground Water Sampling Analytical Parameters
Middletown Airfield NPL Site

Area	Wells	Analytical Parameters
Industrial Area/Main Building Area	Shallow ERM Wells	TCL VOCs + TICs, TCL SVOCs + TICs, TAL total and dissolved metals, CN (total and amenable), TCL Pesticides/PCBs
	Intermediate and Deep ERM Wells	TCL VOCs + TICs, TCL SVOCs + TICs, TAL total and dissolved metals, CN (total and amenable)
	Existing Shallow Wells	TCL VOCs + TICs, TCL SVOCs + TICs, TAL total and dissolved metals, CN (total and amenable), TCL Pesticides
	Existing Shallow Wells (RFW-03, RFW-04, GF-218)	TCL VOCs + TICs, TCL SVOCs + TICs, TAL total and dissolved metals, CN (total and amenable), TCL Pesticides/PCBs
	Shallow Capture Zone Wells	TCL VOCs + TICs, TCL SVOCs + TICs, TAL total and dissolved metals, CN (total and amenable), TCL Presticides
	Intermediate and Deep Capture Zone Wells	TCL VOCs + TICs, TCL SVOCs + TICs, TAL total and dissolved metals, CN (total and amenable)
	Existing Intermediate and Deep Wells	TCL VOCs + TICs, TCL SVOCs + TICs, TAL total and dissolved metals, CN (total and amenable)
	HIA Introduction Wells	TCL VOCs + TICs, TCL SVOCs + TICs, TAL total metals, CN (total and amenable)
	Water Source (Hydrant)	TCL VOCs + TICs, TCL SVOCs + TICs, TAL total metals, CN (total and amenable), TCL Pesticides/PCBs
	Water Tanks (for drilling)	TCL VOCs + TICs, TCL SVOCs + TICs, TAL total metals CN (total and amendable), TCL Pesticides/PCBs
Industrial Area Pipeline	Shallow ERM Wells	TCL VOCs + TICs, TCL SVOCs + TICs, TAL total and dissolved metals, CN (total and amenable), TCL
Lagoon Area	Shallow Well	TCL VOCs + TICs, TCL SVOCs + TICs, TAL total and dissolved metals, CN (total and amenable), TCL Pesticides/PCBs
	Intermediate Well	TCL VOCs + TICs, TCL SVOCs + TICs, TAL total and dissolved metals, CN (total and amenable)

Table D-13 (cont'd)
Site Wide Ground Water Sampling Analytical Parameters
Middletown Airfield NPL Site

Area	Wells	Analytical Parameters
North Base Landfill	Shallow ERM Wells	TCL VOCs + TICs, TCL SVOCs + TICs, TAL total and dissolved metals, CN (total and amenable), TCL Pesticides
	Intermediate ERM Wells	TCL VOCs + TICs, TCL SVOCs + TICs, TAL total and dissolved metals, CN (total and amenable)
	ERM Wells (RFW-01, ERM-12S, -12I, -15I, -31I)	Extra parameter EPA Method 903.1 (alpha emitters)
	Shallow ERM Sentinel Wells	TCL VOCs + TICs, TCL SVOCs + TICs, TAL total and dissolved metals, CN (total and amenable), TCL Pesticides
	Intermediate and Deep ERM Sentinel Wells	TCL VOCs + TICs, TCL SVOCs + TICs, TAL total and dissolved metals, CN (total and amenable)
	Existing Shallow Wells	TCL VOCs + TICs, TCL SVOCs + TICs, TAL total and dissolved metals, CN (total and amenable), TCL Pesticides
	Existing Intermediate Wells	TCL VOCs + TICs, TCL SVOCs + TICs, TAL total and dissolved metals, CN (total and amenable)
	MID-04	TCL VOCs + TICs, TCL SVOCs + TICs, TAL total metals, CN (total and amenable)
	Residential Wells	TCL VOCs + TICs, TCL SVOCs + TICs, TAL total metals, CN (total and amenable), TCL Pesticides
Runway Area	Shallow ERM Wells	TCL VOCs + TICs, TCL SVOCs + TICs, TAL total and dissolved metals, CN (total and amenable), TCL Pesticides
	Intermediate ERM Wells	TCL VOCs + TICs, TCL SVOCs + TICs, TAL total and dissolved metals, CN (total and amenable)
	Existing Shallow Wells	TCL VOCs + TICs, TCL SVOCs + TICs, TAL total and dissolved metals, CN (total and amenable), TCL Pesticides
	Existing Intermediate Wells	TCL VOCs + TICs, TCL SVOCs + TICs, TAL total and dissolved metals, CN (total and amenable)

status of the HIA wells as listed below. The HIA wells where the pump was removed were also purged and sampled. Water samples were submitted to the offsite laboratory for analysis for the parameters listed on Table D-13. The location and status of each production well is summarized on Table D-14. HIA production wells are plotted on Figure D-9A. MID-04 is plotted on Figure D-9C.

Eight residential wells, including the Odd Fellows Home well, were sampled (RES-01 through RES-08). These wells were different than the five residential wells identified as RES-01 through RES-05 on Figure 2-4 of the RI Report (GF, 1990b). The residential wells sampled during this investigation were selected in order to assess the nature and extent of contamination in the vicinity of and down gradient from the North Base Landfill. The residential wells sampled are listed on Table D-15 and plotted on Figure D-10.

The production wells were purged and sampled from the sample tap. There were three HIA production wells that had no pump installed which were sampled as part of this program. They were HIA-10, HIA-17, and HIA-18. Production wells HIA-17 and HIA-18 were drilled on the north side of the Fruehauf Corporation property, but never put into service. HIA-10 has been removed from service. All three of these wells were purged with a low flow pump until the measured parameters stabilized (primarily dissolved oxygen as measured in a closed system). These three wells were sampled directly from the purge line while the discharge rate had been reduced to minimize aeration of the sample. Residential wells were purged and sampled from a tap in the house or alternately near the well itself. Treatment systems were removed or turned off prior to purging, and the system was purged for a minimum of 10 minutes. The sample was collected directly from the tap. A steady, low volume water flow was maintained during sample collection to minimize aeration of the sample.

D.13.4 *Depth Specific Sampling of the HIA Production Wells*

Depth specific sampling was conducted at three HIA production wells to determine the depths at which contaminants are entering the wells. The wells which were sampled included HIA-2, HIA-9, and HIA-13.

The logging and sampling procedures were repeated at each of the three HIA wells in the order described below.

Table D-14
Production Wells Status Table
Middletown Airfield NPL Site

Well	Location	Status
HIA-1	NE of Industrial Area - Service Area C	operational- Sampled
HIA-2	NE of Industrial Area - Service Area C	operational- Sampled
HIA-3	NE of Industrial Area - Service Area C	operational- Sampled
HIA-4	NE of Industrial Area - Service Area C	operational- Sampled
HIA-5	NE of Industrial Area - Service Area C	operational- Sampled
HIA-6	apron south of AMP - Service Area A	operational- Sampled
HIA-7	w/in Hershey hanger. - Service Area B	under concrete foundation, inaccessible, not sampled
HIA-8	on apron west of Hershey hangar - Service Area B	under concrete apron, inaccessible, not sampled
HIA-9	east of bldg. 514 - Service Area A	operational- not sampled
HIA-10	on apron west of Hershey hanger - Service Area B	open cased hole inactive- Sampled
HIA-11	tank farm near Air Traffic Control Tower - Service Area A	operational- Sampled
HIA-12	at water treatment plant - Service Area A	operational- Sampled
HIA-13	south side of bldg. 142 - Service Area A	operational- Sampled
HIA-14	w/in Terminal	operational - Sampled
HIA-16	SW on Fruehauf Corp. facility	non-operational pump in-place, inaccessible, not sampled
HIA-17	north of Fruehauf Corp. facility	open cased hole - Sampled
HIA-18	NW on Fruehauf Corp. facility	open cased hole - Sampled
MID-04	N. Union St., at Frey Village	operational - Sampled

Table D-15
Residential Well Sample Locations
Middletown Airfield NPL Site

Sample ID	Location of Sample
RES-01:	@1091 N. Union Street, Middletown, PA 17057 This well is situated adjacent to the east side of the North Base Landfill, but is still on the west side of N. Union Street. The residence has public water. Total depth unknown.
RES-02:	@1009 N. Union Street, Middletown, PA 17057 This residential drinking water well is situated directly south (downgradient) from the North Base Landfill on the west side of N. Union Street. Total depth is about 180 feet.
RES-03:	@ 1090 N. Union Street, Middletown, PA 17057 This residential well is situated between the North Base Landfill and MID-04 on the east side of N. Union Street. The residence has public water. Total depth is about 154 feet.
RES-04:	@ 1235 N. Union Street, Middletown, PA 17057 This residential drinking water well is situated northeast (upgradient) from the North Base Landfill. Total depth is about 180 feet.
RES-05:	@ 914 N. Union Street, Middletown, PA 17057 This residential well is situated somewhat southeast (downgradient) from the North Base Landfill. The residence has public water. Total depth is unknown.
RES-06:	@ 999 W. Harrisburg Pike, Middletown, PA 17057 Oddfellows Home of PA This private production well is located in a strategic position downgradient from the North Base Landfill. HIA Water Department provides potable water. Total depth is unknown.
RES-07:	@ 105 Rosedale Avenue, Middletown, PA 17057 This residential drinking water well is west of the Oddfellows Home and east of the Meade Heights drainage. This well is downgradient from the North Base Landfill. Total depth is unknown.
RES-08:	@635 Rosedale Avenue, Middletown, PA 17057 This residential drinking water well is west of the Oddfellows Home near the Meade Heights drainage and downgradient from the North Base Landfill. Total depth is about 140 feet.

Figure D-10
Residential Well Sampling Locations
Middletown Airfield NPL Site
Middletown, Pennsylvania

THE ERM GROUP

PM008.07.01/05.11.96-MKB/06.14.96-MKB/I204 -1B

1. The existing pump, if present, was removed from the well and stored for the duration of the testing.

2. ERM's subcontractor, *welenco, inc.*, performed a downhole color video survey to document the visual inspection of the casing and the open borehole.

3. ERM's subcontractor, *welenco, inc.*, performed the following borehole logging procedures while the well was at static conditions, in the order indicated: temperature and fluid resistivity (a combined tool), caliper, spinner flow meter, and natural gamma ray. The logging sequence varied slightly from the order requested by USACE because the temperature and fluid resistivity logs are obtained simultaneously from the same tool; therefore, the caliper log was run after the fluid resistivity log.

4. Ground water samples were collected from five depth intervals in each well during static conditions. The sample depths were selected based on the geophysical logging results and represented significant water bearing zones. The uppermost sample depth selected was the first water bearing zone below the bottom of the installed steel casing. The bottom sample depth selected was the water bearing zone closest to the bottom of the well borehole. The remaining 3 locations were associated with water bearing zones distributed between the bottom of casing and the total depth of the borehole.

   To collect each sample, a specialized sampling device was lowered to the required sample depth. The sampler was constructed of stainless steel 2.125-inch outside diameter, with a volume of 1 liter. The size of the sampler was dictated by the diameter of the access pipe (for samples collected during flowing conditions). Prior to insertion into the well, the air was evacuated from the sampling device and it was sealed. The device was lowered to the chosen depth and the ground water sample was drawn by opening then closing a motor-operated valve. The sampler was then brought back to the surface to fill the sample bottles.

   It was necessary to repeat this procedure several times for each interval to obtain the necessary sample volumes for the required analytical parameters because the maximum sampler capacity was 1 liter. The containers for the TCL VOCs were filled first at each location. The sampler was disassembled and decontaminated between sample intervals according to the procedure described in

Section 3.17. This sampling procedure was repeated until each of the five intervals was sampled.

5. A test pump and access pipe (for the logging and sampling tools) were installed in the well. The pump and access pipe were set as high in the well as possible to minimize interference with subsequent logging of the well under flowing conditions. Pumping began, and the well rate was allowed to stabilize prior to logging. Pumping continued until logging and depth specific sampling are completed.

6. The following logging procedures were conducted, in the order indicated, while the test pump was operating: spinner flow meter, temperature and fluid resistivity. Natural gamma ray logging was not repeated during pumping because the gamma ray signature of the formation was not affected by pumping of the well.

7. Ground water samples were again collected from five depth intervals in each well during flowing conditions. The sample intervals were the same as those already selected and sampled during non-flowing conditions. The same procedures were followed for collecting depth specific ground water samples while the pump was operating as were followed during static conditions.

8. The test equipment was pulled from the well. The original pump was replaced in the well and returned to pre-test operating conditions, as applicable.

The depth specific ground water samples collected from the three HIA production wells were designated with the well number, the sample depth, and a letter designating whether the sample was collected under static (s) or flowing (f) conditions. For example, a sample collected at a depth of 50 feet from well HIA-13 under static conditions was designated HIA-13(50)s.

D.13.5 Water Source Sampling

A hydrant located on the south side of Building 514 (Maintenance Shop) was designated the water source for the field program and was exclusively used for all activities needing water. These activities included decontamination (steam cleaning or washing tasks) and as water used during bedrock drilling (injection water). This hydrant is part of the HIA Water Department potable water distribution system and the sample was collected at the outset of the field program. The hydrant valve was shut down to a low flow rate and samples were collected directly from the hydrant spigot.

D.13.6 Water Tank Sampling

Several water tanks were used to supply water during bedrock drilling. The tanks were filled with water drawn exclusively from the designated water source hydrant. A water sample was collected directly from the drain valve of each tank after it was filled for the first time. The tank drain valve was opened slightly to allow a slow flow of water to permit filling sample bottles at that valve.

D.14 AQUIFER TESTING

D.14.1 SLUG TESTING

In order to evaluate the hydraulic conductivity (K) of the overburden and the bedrock in the different areas of the project site, slug tests were conducted on the 2-inch shallow and intermediate monitoring wells installed by ERM. The areas where the slug test were performed include the Main Building/Lagoon Area, the Runway Area, and the North Base Landfill. The deep bedrock wells, the capture zone wells, and the sentinel wells were not included in this study.

The following monitoring wells were tested:

ERM-1S	ERM-14I	ERM-29S
ERM-1I	ERM-15I	ERM-29I
ERM-2S	ERM-16S	ERM-30S
ERM-3S	ERM-16I	ERM-30I
ERM-5S	ERM-17S	ERM-31I
ERM-10I	ERM-17I	ERM-32I
ERM-11S	ERM-18S	ERM-33I
ERM-11I	ERM-18I	ERM-34S
ERM-12S	ERM-19S	ERM-34I
ERM-12I	ERM-20S	ERM-35S
ERM-13S	ERM-20I	ERM-35I
ERM-13I	ERM-27S	
ERM-14S	ERM-28S	

Discussion of the procedures and results of the slug testing is provided in Appendix J.

D.14.2 PRODUCTION WELL PUMPING TESTS

Contamination at the former North Base Landfill is of concern for the Middletown Borough production well MID-04. Contamination from the Industrial Area was also a concern for the HIA production wells. Therefore, in accordance with the 1990 ROD and the ESD, capture zone testing and analyses were performed for one well each in the western (HIA-9), central (HIA-13), and eastern (HIA-2) grouping of HIA production wells and the MID-04 production well to determine the potential for contaminant migration in response to production well pumping. Pumping tests (72-hour duration) were conducted to provide data for the capture zone analyses. Water level fluctuations in response to pumping were monitored in existing and newly installed wells in the vicinity of the pumping well. Details of the test methods were provided in the Work Plan for Capture Zone Tests and Analyses (ERM, 1995). The Capture Zone Tests and Analyses Report is provided as Appendix K.

D.14.2.1 Background Information

Middletown production well MID-04 at elevation 414 feet, is cased to 51 feet, and has a total depth of 815 feet. Typical pumping rates for the well during 1995 were greater than 600 gpm. A turbine pump is set at 400 feet bgs. Current usage of the well is 24 hours per day.

The western HIA wells, HIA- 6 through 14, are cased to 70-200 feet, and have total depths of 450 to 800 feet. Typical pumping rates are in the range of 100 to 800 gpm. Pump information, current usage data, and more detailed information on well construction and conditions were obtained from the Bureau of Aviation at HIA.

The eastern HIA wells, HIA- 1 through 5, are cased from 100 to 104 feet and have total depths of 450 to 629 feet. Typical pumping rates range from 100 to 250 gpm. Pump information, current usage, and more detailed information on well construction and conditions were obtained from the HIA.

D.14.2.2 Techniques

Approximately one month prior to the beginning of the pumping tests, ambient monitoring of water levels in selected wells was conducted for a period of 7 days. Electronic water level recorders were installed in the wells to record the water level measurements at 15 minute intervals for a 7 day period. Manual checks of water levels were conducted at the beginning, middle and end of the monitoring period using an electronic water level probe to confirm the Hermit® data. Barometric conditions at the area were monitored during the same period.

ERM coordinated with the Middletown Water Department and the HIA Water Department prior to scheduling the pumping tests to minimize inconveniences, and reduce the potential for outside pumping influences to impact the pumping test. Pumping tests were conducted for wells HIA-2 and HIA-9 and recovery tests for wells MID-04 and HIA-13. The water levels in the pumping well and the appropriate monitoring wells were monitored continuously during the 72 hour test. Existing pumping systems were used to perform the pumping tests. Manual checks of water levels were performed periodically throughout the test. Hourly barometer readings were also recorded in the field during the test period. Upon completion of the pumping test, water levels were monitored in the nested wells with electronic water level recorders for approximately 24 hours.

D.15 GROUND WATER MODELING

The ESD required a multiple step approach to developing a timetable for ground water restoration. The steps to complete this task were to include:

- determination of soil contamination leaching to ground water;
- reconfiguring the pumping rates/schedules at the HIA production wells;
- developing a timetable for ground water restoration using the above information and information regarding additional remedial activities; and
- development and analysis of ground water model.

Comparison of constituent concentrations in soil samples against screening criteria specified by the Environmental Protection Agency (EPA) and the Pennsylvania Department of Environmental Protection (PA DEP) did not identify specific source areas that would impact ground water. Since no contaminant source areas were defined, vadose zone modeling and contaminant transport modeling were not warranted. However, 3-dimensional ground water flow modeling was performed to evaluate several pumping scenarios and determine the reconfiguration of the HIA production well rates. A detailed report of the ground water modeling activities is provided in Appendix L.

D.16 QUARTERLY MONITORING

Quarterly ground water monitoring was conducted at the nine sentinel wells in the North Base Landfill area to monitor the potential migration of contaminants to the Middletown Borough production well MID-04. Quarterly surface water and sediment sampling was conducted at the same four locations in the Susquehanna River that were sampled during the initial surface water and sediment sampling event described in Sections 3.10.1. If the stakes marking sample locations were still present, their locations were verified before sampling. If the stakes could not be located, the sampling stations were located based on measured positions recorded during the initial sampling. The quarterly ground water samples and Susquehanna River samples were designated by the same sample location numbers used during the initial sampling event.

D.17 QUALITY ASSURANCE AND QUALITY CONTROL PROCEDURES

D.17.1 QA/QC Samples

QA samples collected and analyzed during the RI included trip blanks, ground water duplicate samples, equipment rinsate blanks, and source water samples (tap water). QC samples consisted of duplicate samples collected from the same location as the QA duplicate samples. QA split samples were submitted to the USACE MRDL for analysis.

D.17.2 Daily Quality Control Reports

Daily Quality Control Reports (DQCRs) were completed each day of field activities by the ERM Field Operations Manager and were transmitted to the ERM Project Manager. During the field work portion of the project, the ERM Project Manager submitted the DQCRs to the USACE Technical Manager on a weekly basis. Copies of the project DQCRs are provided in the QCSR document (ERM, 1996).

D.17.3 Sample Handling and Preservation

Samples were placed into properly labeled sample containers with the necessary preservatives already added by the laboratory. Tables 4-1, 4-2, and 4-3 of the SSI QAPP (ERM, 1994) list the proper container material, volume requirement, and preservation needed for the various sampling media. Sample bottles needed for a specific sampling task were relinquished by the Field Operations Manager (FOM) to the sampling team after the FOM has verified the integrity of the bottles and ensured that the proper bottles have been assigned to the task to be conducted.

Ground water samples that were collected for dissolved metals analysis were field filtered prior to preservation using a Millipore® Hazardous Waste Filtration System. The Millipore® is a pressure filtration system which allows for rapid filtration and is constructed of stainless steel and Teflon® materials which can be decontaminated between uses. An inert nitrogen (N_2) gas supply was used as the pressure source. The sample was poured from the bailer into the Millipore® system and a 0.45-micron pore-sized membrane was used to remove suspended sediment from the sample. The sample was filtered directly into the appropriate sample container, with the necessary preservatives already added.

D.17.4 *Field Calibration*

Field measurements of pH, specific conductance, and temperature were taken during monitoring well development and ground water sampling.

Field equipment was calibrated using standard solutions which have certified concentrations. These standards were purchased from chemical supply houses. The frequency of field calibration procedures included the following:

1. A MicroTip PID was used for field screening of volatile organic vapors from soil samples. The MicroTip was calibrated according to the manufacturer's instructions. The calibration gas was 100 parts per million (ppm) isobutylene. The PID was calibrated at the beginning of each day it was used in the field, and periodically checked throughout the day and recalibrated as needed during the course of the day.

2. The pH meter was calibrated according to the manufacturer's instructions and two standard buffer solutions (pH 4 and 7) obtained from chemical supply houses. The pH value of these buffers was compensated for temperature according to the values supplied on the manufacturer's bottle label. The pH meter was calibrated a minimum of once at the beginning of the day and documented in the calibrator's field book. Calibration was checked mid-day and at the end of the day to ensure proper measurements were taken.

3. Temperature measurements were performed using a field thermometer recorded to $\pm$ 0.2 degrees Celsius. The thermometer was calibrated at the ERM warehouse, by qualified personnel, to a certified NBS thermometer.

4. Specific conductance meters were calibrated according to manufacturer's instructions using a 1000 µmhos potassium chloride solution prepared by ERM. The specific conductance meter was calibrated a minimum of once at the beginning of the day and documented in the calibrator's field book. Calibration was checked mid-day and at the end of the day to ensure proper measurements were taken.

5. A Hach® turbidimeter was used to measure turbidity levels in the ground water. Hach® turbidimeter is pre-calibrated by the manufacturer with formazin primary turbidity standard and does not require recalibration before use. The calibration was checked daily using gelex secondary turbidity standards to ensure that the

instrument calibration had not drifted. The values obtained from these calibration checks were noted and used to track the instrument performance.

ERM's field geologist was responsible for daily calibration of field equipment.

D.17.5 Data Validation

A full data validation was performed on ten percent of all data, and the remaining 90 percent was evaluated for holding times and blank contamination only, per the USACE project-specific requirements. The field and laboratory QC activities, as well as the results of the data validation, are summarized in the QCSR (ERM, 1996) which is provided as a separate companion document to this report. Data validation summary reports, validated Form 1's, and the DQCRs are included as attachments to the QCSR.

Immediately after sample collection, each sample bottle was sealed in an individual plastic bag and placed into an insulated cooler for shipment to the laboratory. Sample coolers were packed with double bagged conventional ice to maintain a temperature of 4°C until the sample was received by the laboratory. Samples were packed in a manner to prevent damage to sample containers during shipment to the laboratory.

Section 5.0 of the SSI QAPP provides detailed information regarding proper sample labeling and chain-of-custody documentation. ERM field Chain-of-Custody records and ERM Traffic Report forms were completed at the time of sample collection and accompanied the samples inside the coolers during shipment to the laboratory. These record forms were sealed in a plastic bag and taped to the underside of the cooler lid. An additional form, entitled "Characterization of Environmental Samples for Disposal", was also included in shipments to the MRD Laboratory. In addition, shipments to MRD Laboratory were assigned project specific LIMS numbers, which were written on the chain-of-custody and Traffic Report forms. Each sample cooler was sealed with signed ERM custody seals, and the coolers were shipped by an overnight courier in accordance with current US DOT regulations. Additional details concerning sample handling are described in Section 5.0 of the SSI QAPP.

D.18 DISPOSITION OF INVESTIGATION-DERIVED WASTE

Investigation-derived wastes (IDW) included cuttings from borings and monitoring well installation, decontamination fluids, well development purge water, water purged from wells during sampling or aquifer testing, and miscellaneous personal protective equipment (gloves, etc.) These IDW were handled as described below.

D.18.1 Cuttings from Soil Borings and Monitoring Wells

Cuttings generated from the drilling of monitoring wells and soil borings at the Site were placed in water tight rolloffs. Rolloffs were supplied by Hydro Group, Inc. of Meadeville, PA, Edward Armstrong and Sons, Inc. of Lancaster, PA, and Waste Management of Central PA in Camp Hill, PA.

During the bedrock drilling at the Site, the rolloffs were placed directly next to the drilling rig and received the cuttings and water directly from a discharge hose. The water from the drilling was decanted off to a second rolloff or removal using a vac truck and the rolloff was moved to the staging area pending removal from the site. Cuttings generated during the drilling of the shallow monitoring wells and the soil borings were collected into steel drums and transported to the staging area. The soil from the drums was then transferred into the rolloffs. The removal of water from the rolloffs was necessary prior to shipment to the landfill because if the material was too wet or if there were any free liquids in the rolloffs, the rolloffs would not be accepted by the landfill. Therefore, cuttings were mixed with a drying agent acceptable to the landfill. The drying agent mixed with the cuttings was primarily sawdust, but rock dust was used when sawdust was unavailable. A backhoe was used to mix the drying agent into the rolloff in preparation for shipment. ERM's subcontractor for the on-site bulk handling of sediments using a backhoe was Hydro Group.

These cuttings were sampled at the outset of the program when a representative collection of wells and soil borings had been drilled in the Main Building area, at the lagoons, and around the North Base Landfill. The samples were composited from all rolloffs available at the time. The samples were analyzed by an offsite lab for: full TCLP suite, Metals (as received and 8 RCRA plus Cu, Zn, Ni, and Mo), VOCs (EPA 8260), SVOCs (EPA 8270), Pesticides/PCBs (EPA 8080), TPH (EPA 418.1), and TOX Total Organic Halogens (SW 846/EPA 9020). An application Form U, Request to Process or Dispose of Non-Hazardous Residual Waste was submitted to PADER Waste Management Program. This request was granted. The transporters of the rolloffs to the landfill were Waste Management of Central PA and Edward Armstrong and Sons, Inc. The landfill that received the cuttings was Modern Landfill and Recycling in York, PA.

The decontamination pad was excavated and removed at the end of the field program. ERM's subcontractor for the removal and excavation of the decon pad was Edward Armstrong and Sons, Inc. The excavation was extended 1 to 2 feet below the original excavation depth and approximately 1 to 2 feet laterally in the area of the sump. This was done to remove all soils potentially impacted by decontamination activities. The excavated soils were all placed into rolloffs. All railroad ties were segregated and placed into rolloffs for disposal. Sediments that had accumulated in the 20,000 gallon water tank on site were removed and placed into rolloffs for subsequent disposal.

During the course of the investigation, 56 rolloffs containing a total of 733.22 tons of material were disposed of at Modern Landfill . The vast majority of the sediment volume was generated by the drilling of the intermediate and deep bedrock well boreholes. There were two rolloffs of railroad ties that had been removed from the former decon pad. These were disposed of as regulated municipal waste, residual waste, and source separated recyclable materials. The ties were hauled to Lancaster County Solid Waste Authority, Conestoga, PA. The railroad ties were chipped and incinerated. Any steel drums used temporarily during the field investigation had the ends cut off, and then were steam cleaned, crushed, and hauled to Kimmel Scrap in Lancaster, PA. The drums were subsequently shredded and sold as scrap.

Prior to releasing the rolloffs to their suppliers at the end of the field program, the rolloffs were thoroughly washed. Washing consisted of the removal of all coarse materials by shovel or broom, followed by a high pressure and high volume wash of the interiors and exteriors using a fire hose connected to the designated water source hydrant. Further scrubbing, using brushes and a non-phosphate soap, was done only as needed.

D.18.2 Water Generated During Development, Purging, or Aquifer Testing

All water generated during drilling was collected into rolloffs, into a temporary 4,000 gallon poly tank, or into drums. This water was decanted from the rolloffs, or pumped from the tanks or drums and transported on-site to a 20,000 gallon collection tank located at the staging area and adjacent to the decontamination area. It was originally planned that water generated during drilling or other site activities would be sent to the HIA's POTW or to the on-site lagoons. Permission to discharge water to the HIA's POTW or the lagoons was not granted.

PADER Bureau of Water Quality Management granted permission to discharge IDW water generated during field investigative activities provided notification of PADER was made for each discharge event. The accumulated drilling derived water was then allowed to discharge from the holding tank into the storm sewers at the grated vault on the south side of Building 514. Water generated during well development, water sampling, or during pumping tests was discharged directly to the storm sewer system in the vicinity of the wells being pumped. Notification was given to PA DER for each of these discharges. All drums used to transport water to the holding tank were emptied, then stored at the staging area for reuse.

D.18.3 Decontamination Fluids

Decontamination fluids included wash water (containing a nonphosphate soap), 10% nitric acid, and pesticide-grade methanol. Decontamination water was collected and pumped into the 20,000 gallon holding tank at the staging area. The volume of the nitric acid rinsate was minimal. This liquid was placed in 55-gallon drums for subsequent testing and disposal as IDW. Methanol rinsate was also contained in a 55 gallon drum and segregated from other IDW decontamination fluids. It was stored on-site pending proper disposal as IDW. Both of these liquids evaporated very quickly and disposal was unnecessary. The drums used to store these spent decon fluids were stored at the staging area.

D.18.4 Personal Protective Equipment

Personal Protective Equipment (PPE) that was non-disposable was cleaned per the procedures discussed in the Health and Safety Plan (ERM, 1994). Disposable PPE (such as latex gloves, Tyvek suits, etc.) was placed in a 55-gallon drum for subsequent disposal. At the end of the field investigative activities, the spent PPE was disposed of at the landfill under the category of Non-Hazardous Residual Waste as were the drill cuttings.

D.18.5 *Handling of Drummed Waste*

Other than the drums used to store disposable PPE and decon fluids, drums were not used to store IDW such as drill cuttings, or purge water. The drill cuttings that were collected into drums were immediately transferred into water tight rolloff containers. These drums were steam cleaned and set aside for reuse. Purge water from wells or boreholes that was put into barrels was transported to the staging area and pumped into the 20,000 gallon storage tank pending discharge. These drums were then set aside for future use. At the end of the field investigative activities all drums were thoroughly steam cleaned and the ends were cut off and sold as scrap metal. One rolloff of cleaned and crushed drums was hauled to Kimmel Scrap Iron in Lancaster, PA, where the drums were shredded and sold as scrap metal.

D.19 *SURVEYING*

A base map of the Middletown Airfield site was prepared from an aerial survey conducted during 8 and 13 April 1993, by Data Reduction Associates, Inc. (ADR). A digital drawing file of the site, represented both planimetric features and topography at a 2 foot contour interval, was provided to USACE as a project deliverable.

All soil boring geoprobe, and surface water/sediment sampling stations associated with the SSI were plotted on the base map based on field measurements from available landmarks. Existing monitoring well locations had been surveyed for top of casing elevation, but not for horizontal coordinates. The locations of existing monitoring wells plotted on the base map were also based on field observations.

All wells installed by ERM as part of the SSI were surveyed by Rettew Associates, Inc. of Lancaster, PA, a licensed professional surveyor in the State of Pennsylvania. The map coordinates were determined using the State Planar grid. Elevations of the ground surface and the top of the uncapped well casings were determined in reference to the National Geodetic Vertical Datum of 1988.